VOL. XV, NO. 3 JULY, 1933 Old Series Vol. XXXI, NO. 3

The Journal of Bone and Joint Surgery

PRESIDENTIAL ADDRESS*

BY ARTHUR STEINDLER, M.D., IOWA CITY, IOWA

In response to precedent and tradition most of my predecessors have dedicated their addresses to orthopaedic progress and achievements of the immediate or remote past. Many a forceful message and wise counsel, built upon such historical background, has been delivered to this Society on these occasions.

As I address you today, I too have a cause to plead, which I fancy may be of some influence upon the future development of orthopaedic surgery.

My ambition, however, does not rise to the point of delivering a message and if, in the exposition of the case, allusions are made to historical events, they are meant only to give a basic structure to the argument. There is no intention of indulging in prophecies or exhortations.

Sufficient time has elapsed since the so called independent existence of orthopaedic surgery in this country to make us thoroughly conscious of the true sources of our proficiency. We are rejoicing that these sources of knowledge have come to us from all nooks and corners of natural sciences, until we find today that clinical medicine and basic and allied sciences alike are united to supply us with food and fuel necessary for our work. History tells us, however, that the conquest of theoretical medicine and its allied fields has not always been carried on with the undivided support of the rank and file of the profession. It seems that much arguing and pleading were necessary, judging from what is reflected in the presidential expressions of earlier years.

At first, it was pointed out to this Society that it was the prominent surgeon of the old days who really did all the orthopaedic work. It is to him that we owe the establishment of the bill of rights of orthopaedic surgery among medical sciences.

E. H. Bradford, in 1889, in his address before the Association, de-

* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.

scribes it as a pioneer Society which owed its inception to the genius of men like Delpech, Bouvier, Malgaigne, Macewen, Stromeyer, and Thomas. These were all general surgeons of the present and past centuries. There is frequent mention of Ambroise Paré who, three hundred and fifty years ago, made clinical use of the adaptability of tissues for gradual correction of deformities, and of John Hunter who, two hundred years later, became the great champion of the restorative powers of nature.

Next, it was reasoned that inasmuch as the great surgeons of the past were orthopaedists, so the orthopaedist of today must be a surgeon before he may aspire to proficiency in his work. The acceptance of this prerequisite has actually laid the corner-stone for a standardization of orthopaedics as a surgical science. In 1894, Phelps, in his annual address, deplores the odium of the so called "strap-and-buckle specialty" and claims as indispensable background for the orthopaedic surgeon a perfect knowledge of anatomy and pathology, a viewpoint implicitly shared by Ridlon in his address (1895), when he paid particular tribute to two general surgeons of the nineteenth century, Little of London and Detmold of New York.

It is commonly assumed that orthopaedic surgery established its independence earlier in this country than it did anywhere else, thanks to the creative influence of Sayre, Phelps, and Taylor. But this must not be understood to mean that it has ever drifted away from general medicine. On the contrary, we see it has become increasingly dependent upon and affected by general medical knowledge. Osgood in his address in 1921 issued an urgent call for an all-embracing medical background for the orthopaedist. But the idea has never been better expressed than by the lamented Allison in 1922 when he pointed to the difference between the technical perfection and a real deepening of our knowledge. "If we were bent upon technical perfection alone," he said, "it would be easy to refine our methods from within themselves and devote ourselves to the cultivation of fool-proof proceedings." Indeed, all of us have seen the time when such a narrow tendency has threatened to prevail in our profession. However, later developments have borne out that the broader path, advocated by Allison, was the one chosen; orthopaedic progress appears intimately interwoven with contemporary progress of medical sciences. For this it may not deserve special credit, since this trend became universal in medicine. At any rate, we are today less specialistic than we ever were and much more universalists in medicine than our elders a generation ago. In the stricter sense, therefore, the term of orthopaedic surgeon has become inadequate; we should be called orthopaedic physicians.

The new urge for universal medical knowledge permeates actual orthopaedic practice as much as it does orthopaedic teaching and orthopaedic research. One of our committees is at present actually engaged in investigating what is and what is not good orthopaedic teaching in the light of general medicine. In the near future I hope to see a similar

committee investigating from the same point of view what is and what is not good orthopaedic research.

With all due deference and gratitude to the morphological sciences, anatomy and pathology in particular, the inestimable value of which may never be belittled or disputed, it is not too much to say that at present orthopaedic progress is earmarked by its alliance with physiological sciences.

There was first the biology of regeneration, particularly of bone growth, stimulated by newer operative methods. Its clinical application reaches back to Ollier, Macewen, and Lexer.

Then came biochemistry which has always played an important rôle as an ancillary branch from the days of Trousseau and Kassowitz to the present day, and which has so generously contributed to our knowledge of metabolic orthopaedic disorders that today no orthopaedic record can be considered complete without a biochemical analysis.

Then, not many years ago, there was a revival of the physiology of the sympathetic system, instigated by men like Royle and Hunter and Leriche, and productive of a wealth of theoretical investigations in this field.

Very recently orthopaedic surgery has again become particularly interested in the physiology of the endocrines, especially of the parathyroid glands. This contribution is not new, as may be learned from a study of Erdheim's earlier publications thirty years ago which established the relationship between the parathyroid glands and bone disease. Its clinical significance for the study of certain bone and joint disorders is at the moment a matter of actual controversy and is too recent in your memory to need further mentioning.

This new physiological current underlying orthopaedic progress can be illustrated by so many instances that one may well wonder if there is any corner left that has not yet been carefully exploited for what it might yield to practical orthopaedics.

There is, I believe, one field of physiology which has not yet been so explored and which, so far as practical orthopaedic surgery is concerned, is still virgin soil. I have in mind the part of physiology covering the mechanics of locomotion,—the biophysics of the locomotor apparatus. For practical applicability this field seems to promise a rich harvest; it is full of possibilities for the clinician. If this is the case, why then has it escaped exploitation? The answer is that it is complex and difficult for investigation and that it exacts a certain amount of abstract studies to which the morphologist, always dealing with concrete conceptions, is rather unwilling to devote himself.

In the historical sense, biophysics of the locomotor system is anything but new. In fact, it was almost inevitable that the physical sciences should sooner or later enter into an alliance with medicine. Yet, compared with biochemistry, biophysics today has little to offer in the line of established facts, whether they relate to physical properties of the locomotor system or to the calculation of its mechanism.

In stating that the study of biomechanics of the human body is not new, reference is made to sporadic and disconnected efforts which can be traced through almost all the history of medicine. As early as the sixteenth and seventeenth centuries, at a time when biochemistry and electrophysics were still outside the bounds of imagination, the ground was well prepared for biomechanics by Leonardo da Vinci and Galilei. It is interesting to observe that valuable physical observations on the locomotor system were made by men who were still enmeshed in the old fluid theory of Galen. Croone (1633–1648), for instance, interpreted muscle contraction, and Glisson, three hundred years ago, recognized the constancy of muscle volume in contracted and relaxed conditions. In his work "De Motu Animalium", Borelli (1685) was the first to depart from the purely morphological point of view by treating the subject of human locomotion from the angle of physical analysis. But he was an elementary analyst since he applied only the most elementary mechanics to his human material, and he was still largely ignorant of the intrinsic physical properties of the tissues concerned.

The school of iatrophysicists, one of the three great schools of the seventeenth century medicine, represented the biomechanical line of thought and extended its influence into the seventeenth, eighteenth, and nineteenth centuries. It is common knowledge that the discovery of electrical reaction by Volta and the promulgation of the laws of Newton laid the foundation to the later studies of Haller (1708–1777), the great physiologist who discovered the sensibility and irritability of human tissue and created a monumental background for the future development of biomechanics.

From our present point of view, even his investigations into the physics of locomotion must be considered elementary, erroneous, and inadequate. One has to turn to Hermann v. Meyer and particularly to the Weber brothers in the first half of the nineteenth century for such distinctive clinical investigations as have retained recognition to the present day. Particularly has the treatise of the Weber brothers on the mechanics of the human gait remained a classic. Claiming a wide range of authorities, from Aristotle to Borelli, from Galen to Haller, and their contemporaries Magendie and Roulin, they were able to formulate certain laws for the walking and running gait which expressed the relationship between horizontal elevation, step length, swinging angle, velocity, and force, such as are still generally acknowledged as accurate and true.

One may well imagine with what degree of skepticism such abstract studies must have been received by the rank and file of the clinicians who certainly did not see then the significance of theoretical facts for practical application. To express in mathematical terms complicated physical processes seemed too bold an undertaking. But the Weber brothers emphatically disclaimed any such ideas. They did not intend to make their observations and measurements the basis upon which general laws of mechanics were to be formulated. They knew that this would be

preposterous in the face of the many unknown factors which enter into human locomotion. On the contrary, the law being first recognized and accepted as universal, their point was to show whether and to what extent any phase of locomotion which lends itself to analytical studies could be demonstrated to conform to existing mechanical laws or, to put it in simpler terms, could be shown to be a special case of this law. This attitude of making the interpretation of locomotor events strictly contingent upon existing general laws has, I believe, steered biophysics of locomotion safely around the most dangerous cliffs and has saved it from an abyss of useless speculation. Its effect on future progress cannot be overestimated. It was in the latter half of the last century that Marey (1872), Duchenne, and later Fick, Strasser, and still later Braune and Fischer developed their classical studies on human motion and human gait. The ceaseless labor of such men has transmitted to us a wealth of data which to the casual observer may appear dry and tedious, but from the angle of mechanical laws they are full of meaning. They are as important for the dynamics of locomotion as are Culman's, Wolff's, and Roux's much quoted contributions to the statics of the human body.

Indeed, it is due to the studies of Wolff and his successors that everybody today accepts as a fact the all-important and dominant influence of mechanical laws in determining form and function of the normal system of locomotion.

Physiology has, moreover, gone considerably beyond this point when it applies the laws of thermodynamics to the study of locomotion. By this is meant a correlation of the measurable mechanical work with the amount of energy expended.

It has, thereby, built up a fairly accurate and a very much needed scientific standard for the efficiency of many of the normal locomotor events. Men like Chauveau (1897), and Amar in France (1913), Durig, Lewy, Zuntz in Germany, Benedict and Cathcart in this country, and Hill and Fenn in England, have made most valuable contributions to this problem, and so convincing have been the results of their studies on mechanical efficiencies of all kinds of locomotor activities that both physical education and industry alike were eager to avail themselves of this stock of knowledge for their own particular ends. Physiology starting with systematic observations, measurements, and trials has finally reached the point where a mathematical expression could be given to many of the locomotor events, and where, moreover, their motor efficiency could be stated in percentage figures.

Surely, if all this could be accomplished by studies of physiological motion, it is reasonable to expect similar results for pathological motor activities. I am here reminded of a thought I heard expressed by one of our most profound orthopaedic thinkers, now dead: "The cripple," he said, "is no caricature of the normal man; he is a unit, a device of nature all his own." This seems to apply, above all things, to the mechanical make-up of the locomotor system. We may well ask ourselves whether

to date physiological research has revealed an amount of facts applicable to the pathological side of locomotion, similarly as it has served normal motor activities; or whether it should be necessary to repeat the whole process of investigation from the pathological angle. To a large extent, I fear, the latter is true. Pathomechanics of the human body is still unbroken ground. There have been, it is true, sporadic investigations on selected problems. For instance, contributions have been made on the physical properties of structures making up the locomotor system. The pressure, the torsion, the bending resistances of many of the long bones are known; so are, to a degree, the elasticity and contractility of muscle tissue, and its resistance to elongation in the relaxed and contracted state. Such facts, even though arrived at from normal tissue, go far to elucidate the mechanogenesis of many pathological conditions, for instance, of fractures and muscle contractures.

Also, the various problems of equilibrium have been analyzed nicely for the upright position in a number of weight-bearing joints.

This sort of analysis, however, has not been carried over much into pathological situations. Posture, for instance, is still defined largely in purely morphological terms and, though gravital stresses are, of course, generally recognized as being the basic factor, there are few, if any, investigations which treat the situation from the viewpoint of mechanical analysis of the external gravital forces as they act upon the human body.

Sequence and coordination of muscles in any kind of concerted motion is another field of analysis. Here, we are particularly indebted to Scherb of Zurich for his studies of so called myokinetics of certain types of motion. These investigations of the plan and arrangement of muscle action—the muscle score as it might be called—are very valuable, because they can be used for pathological situations and very useful information can be obtained in regard to the substitutionary properties of muscle action or in regard to functional adaptability of transplanted tendons.

There are many other lines of biophysical research which may be carried over to pathological territory. For instance, action-current readings have been made in all kinds of paralytic and spastic conditions. As an index of pathological muscle activity, such readings throw light on more than one perplexing situation in locomotor disturbances.

Another very promising field is the study of energy consumption in pathological motion. Just as it enables us to arrive at an index of proficiency for normal motion, so it may do for the abnormal, and one may well imagine what convincing record it would make before and after treatment, if endurance as well as proficiency could be calculated and compared with standard values.

I do not need to go any further to prove that the field is vast and largely unexplored. It is safe to say that a considerable time will elapse before sufficient theoretical facts are available for practical clinical use. However, there is comfort in the thought that other basic sciences have met with similar fate; they, too, had to develop quietly in the background

of clinical medicine before the sheer weight of their vast and useful practical information forced their recognition.

I trust that I have not allowed my zeal to overstep the bounds of impartial reasoning. But I visualize biomechanics as a powerful and indispensable ally of the orthopaedic clinician. Many of my colleagues, I trust, will be attracted by the intriguing problems in this field and I hope to see the day when systematic and coherent research in the domain of biophysics of locomotion will open the way for greater proficiency and will mark a definite advance in orthopaedic surgery.

Two years ago, Gentlemen, you honored me above all merits by the election to this office. I am grateful to you beyond words, my gratitude being only intermingled with misgiving lest I have not been able to conduct this office on the high standard to which it has been elevated by my more illustrious predecessors. You may recall that on that occasion I indicated my faith in the future importance of biophysics for orthopaedic surgery, an opinion which, if my memory serves me right, you graciously accepted.

Today, in my presentation, I again have set before you this line of thought, to which I have devoted much time and study, as an article of my orthopaedic faith. Allow me to place it in your hands with the assurance of my undying loyalty to you and to American Orthopaedic Surgery.

INFANTILE DEFORMITIES OF THE KNEE AND HIP *

BY OBERREGIERUNGS-MEDIZINALRAT DR. MAX BÖHM, BERLIN, GERMANY

I feel very much indebted for the opportunity you have given me to demonstrate here my research work of recent years.

What do we know about the cause of infantile deformities of the leg,—for instance, of knock-knee, of bow-leg, or even of flat foot? We know that all these deformities may be produced by many different causes, such as rickets, poliomyelitis, osteomyelitis, or old fractures.

But, aside from these recognized causes, there still remains a rather large number of cases, in which the etiology is unknown. Among these are cases of a certain type of deformity of the leg,—such as a bow-leg or a knock-knee, or a hyperextended knee, a weak ankle, or a flat foot—rarely a deformity of an extreme type, but mostly of a moderate or of a mild degree, so that sometimes there is very little difference from the normal.

These deformities which we meet daily show no history of rickets, osteomyelitis, or old fractures. They cannot be attributed to any of the known causes and, therefore, they have been explained by all possible theories and hypotheses.

FIG. 1

Upper epiphysis of the tibia in foetus of seven months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

In accordance with the mechanical conception of natural science in general, in the past century, these "*infantile*" deformities—as I like to call them now—were explained by mechanical causes. We believed in a wrong function, in a faulty attitude, in the effect of overweight,—in brief, in abnormal static conditions—all this without any real basis, without any proof; we believed simply because we did not know better.

I do not wish to add a new theory to the dozen of old theories, but to try to put the etiology of infantile deformations, as we now understand them, on an anatomical basis.

In this paper we are to consider especially the deformities of the knee and hip.

DEFORMITIES OF THE KNEE

Genu Varum.

A brief, anatomical, comparative study shows that in the anthropoid the condyles of the tibia differ widely from each other; the lateral one is

* From a paper presented at the Meeting of the British Orthopaedic Association, London, July 27, 1932.

always much broader and higher than the medial one, whereas in an adult man both tibial condyles are equally high and both show a concave joint surface.

An x-ray of the tibial epiphysis of a nearly adult gorilla shows a marked asymmetry that means the overdevelopment of the lateral and the underdevelopment of the medial condyle. In a young human foetus (Fig. 1) it is evident that the tibial epiphysis still has anthropoid characteristics,—the lateral condyle is high and convex; the medial condyle is low and concave. If the two joint surfaces are placed horizontally, the shaft of the tibia is deviated inward and a genu varum results.

FIG. 2

Upper epiphysis of the tibia in child seven years old. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

In young children the tibia is similar to the foetal tibia; a cross section shows that the lateral condyle is high, the medial low; that the lateral is convex, the medial concave; and finally that the shaft is deviated inward.

In a child of about twelve years of age the conditions are entirely different (Fig. 2). The epiphysis is now symmetrical; both tibial condyles are of the same height; both are concave; and the shaft is now straight.

If the child grows and the tibia keeps its foetal type, a genu varum results.

Genu Recurvatum.

Quite often young children show a *hyperextended* knee, particularly in connection with a genu varum or genu valgum. What is the cause?

The knee of the anthropoid shows an interesting feature,—the head of the tibia is curved backward. The same recurvation is to be seen in the human foetus. In a mild degree it is present in the young child and not until the tenth year do the recurvation and the subsequent inclination of the joint disappear.

FIG. 3

Model of lower epiphysis of the femur in embryo of two months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

FIG. 4

Lateral view of acetabulum in foetus of five months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

Furthermore, the condyles of the femur in the anthropoid differ in an interesting way from those in the human being. In man the femoral condyles show the well known curve, which may be best compared with the curve of a sledge; in the adult anthropoid the curve forms a part of a circle.

The development of the femoral condyles during childhood may be mentioned. These are round in the embryo, in the foetus, and in the new-born, gradually changing to the final flat shape evident in the adult.

If the recurvation of the tibia and the round shape of the femoral condyles persist in childhood, a hyperextended knee must result. The roentgenograms of clinical cases of infantile hyperextended knees show clearly the recurvation of the tibial head.

FIG. 5

Posterior view of the acetabulum in foetus of five months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

Genu Valgum.

Study of the knee of an anthropoid shows that there is a marked difference in the volume and height of both femoral condyles. The medial is much larger and higher than the lateral condyle. In a roentgenogram of the knee of an anthropoid almost an adult, the underdevelopment of the lateral femoral condyle may be seen very clearly. It is only in the human *adult* that both condyles are of equal size and that the lateral one shows the same height and shape as the medial. I have studied very many human knees of different ages before and after birth and have found in all knees of embryos an underdevelopment of the lateral femoral condyle (Fig. 3). The same is true of the knees of all foetuses examined, as is shown in cross sections. Finally, even the femora of children show the difference in the height of the condyles, in a measure comparable to the age of the child.

If the foetal underdevelopment of the lateral condyle persists, it is clear that a genu valgum must result.

What do the roentgenograms of clinical cases of knock-knee show? The typical appearance in the cases which are undoubtedly due to rickets is the deviation of the shaft and of the diaphysis or the metaphysis, whereas the epiphysis and particularly the condyles show no abnormality in shape or height. On the other hand, the x-ray of an infantile—as I call it now—genu valgum, a so called static genu valgum, shows no

FIG. 6

Lateral view of the acetabulum in an adult. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

deviation of the diaphysis, and the shafts of the tibia and femur are straight; but the epiphysis is asymmetrical; the lateral condyle is developed less than the medial, is decidedly small, short, low, and very little curved,—exactly as we find it in the knee of the embryo or foetus.

CONGENITAL DISLOCATION OF THE HIP

The chief difference in the construction of the acetabulum between man and the anthropoid is the following: The human acetabulum has a roof above and behind. This roof, which prevents the sliding of the femoral head, is entirely lacking, for instance, in the gorilla. The gorilla does not need this posterior roof on account of the peculiar inclination of the pelvis.

FIG. 7

Posterior view of the acetabulum in an adult. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)

The acetabulum of the human foetus shows the same characteristics as that of the gorilla,—that is, a roof is found only above; the posterior roof is entirely lacking. Besides this, there are differences in the shape of the acetabulum; the acetabulum of a human adult is round like a circle; whereas that of a gorilla is oval in shape like a lemon. The human foetus has likewise an acetabulum of oval shape. If a human foetus suddenly started to walk with a straight leg and with an inclined pelvis just like a human adult, the head of the femur doubtless would slip out!

If we study cases of dislocation of the hip in very young children who have not walked and where no therapeutic manipulation has been done, we find exactly the anatomical conditions of the acetabulum of a foetus,—that is, lemon-shaped and lacking the posterior roof.

SUMMARY

If I were asked to give a summary of my research work of the past ten years, I would say:

Just as in modern medicine we know that there is a predisposition to certain diseases, such as tuberculosis, so there is likewise in certain human beings an inherited disposition to certain infantile deformities, based upon an arrest of development in certain parts of the skeleton,—particularly of the ankle, knee, and hip joints and their epiphyses. If this arrest of de-

velopment continues during childhood, the erect position and the gait produce, increase, and stabilize deformities.

As to the cause of this arrest of development, two points are of significance: We know clinically that the infantile deformities have a tendency to familial and hereditary appearance and that anatomically their morphological substratum is identical with the normal conditions of certain animals, such as the anthropoid. Thus I consider the infantile deformities as congenital in a wider sense.

LUMBOSACRAL FACETECTOMY FOR POST-FUSION PERSISTENT SCIATICA

BY PAUL C. WILLIAMS, M.D., AND LUIS YGLESIAS, M.D.,
ANN ARBOR, MICHIGAN

From the Department of Surgery, University of Michigan

It is a well recognized fact that there are occasionally cases of sciatica which do not get relief from either a trisacral or a lumbosacral fusion.

Recently there was published in the *Journal of the American Medical Association*[1] an article in which was described a lesion of the lumbosacral joint which in this clinic had been found in seventy-four per cent. of the cases suffering with sciatica due to pathological bone or joint changes. The lesion consisted of a narrowing or a complete loss of the lumbosacral intervertebral disc, which in turn had caused a subluxation of the joints formed by the articular facets of the fifth lumbar and first sacral vertebral bodies, a constriction of the foramina formed by these segments, and an arthritic lipping of the adjacent surfaces of these two bodies, which had resulted from the abnormal contact and stress following the loss of the disc.

From a roentgenographic standpoint, it is well to divide these patients into two groups: first, those whose roentgenograms show a complete loss of the disc; and second, those whose x-rays show a narrowing of the lumbosacral disc only posteriorly. An example of the first type is shown in Figure 1; Figure 2 is an example of the second type. The latter usually causes more confusion as to its interpretation than does the former, being read frequently as a normal lumbosacral spine. This error is demonstrated in the anatomical specimen and its roentgenograms, shown in Figures 5, 6, 7, and 8. The mechanical alteration in the region of the articular facets and foramina and, therefore, the irritation of the fifth lumbar nerve roots is as great, if not greater, in the second group, than in the first.

The roentgenographic finding shown in Figure 2 is a very common lesion, which probably is the reason that no significance has been attached to it. However, in our experience every patient, whose x-rays show this finding, gives a history of pain in the lower part of the back and down one or both extremities, which usually occurs in attacks. One should bear in mind that this is a condition which in most cases does not produce continuous symptoms. It is, therefore, possible to find the lesion in patients who are not complaining of the characteristic symptoms and who do not present the usual clinical findings. However, a history will reveal that they are subject to attacks of what they usually term "lumbago" and "sciatic rheumatism".

We do not wish to imply that all cases of sciatica are due to pathological bone or joint changes, nor that those which are, are all due to a

FIG. 1

Lumbosacral spine of patient suffering with sciatica. Note complete loss of the lumbosacral intervertebral disc and the arthritic lipping.

loss of the lumbosacral disc. Every case should have a thorough neurological examination and the usual search for any toxic chemical or mechanical irritation. However, as we continue our study of this disease, we find that the number of cases showing a reduced lumbosacral joint space fully sustains the percentage indicated in the original article, while cases due to lumbosacral anomalies undoubtedly constitute a larger percentage than originally indicated. This is especially true in those cases showing a unilateral sacralization of the fifth lumbar vertebra and in those showing a lumbarization of the first sacral vertebra. We believe that irritation of the nerve root in this group is due to practically the same mechanical alteration as in those cases showing a loss of the lumbosacral disc.

There is considerable confusion as to the application of the terms sciatic neuralgia and sciatic neuritis. The neurologist makes the diagnosis of sciatic neuritis when there are definite motor or sensory changes, while the term neuralgia is applied to those cases which have pain without neurological changes along the course and distribution of the sciatic nerve. It is our opinion that most cases start with a neuralgia and, as the irritation increases in severity and the clinical course becomes prolonged, there may be both motor and sensory changes, so that the end stage of a severe case presents a sciatic neuritis. This clinical picture is uncommon as compared to the number of neuralgias one sees. In many respects a sciatic neuritis compares favorably with the clinical course of a neuritis of the upper

extremity resulting from pressure produced by a cervical rib, except that the latter usually runs a longer clinical course.

The pain in a sciatic neuralgia and the nerve changes in a neuritis are usually confined to the distribution of the fifth lumbar nerve segment. This is verified in a case of neuralgia by the fact that one of the most common sites of complaint is the sacroiliac and superior gluteal region, or the region supplied by the superior gluteal nerve which is principally a branch of the fifth lumbar nerve segment. The other common site of pain is the posterior lateral aspect of the calf and ankle, which area corresponds to the sensory distribution of the fifth lumbar segment. In two cases of neuritis which we have seen during the past year, both of which had

FIG. 2

Lumbosacral spine of patient suffering with sciatica. Note that anterior width of lumbosacral disc is retained, but posteriorly the width is entirely lost. The slight posterior displacement of the fifth lumbar vertebra on the first sacral, as shown in this case, is not an uncommon occurrence in this lesion.

TABLE I

INNERVATION OF THE LEG MUSCLES

Muscle	*Nerve Supply*			
Flexor digitorum longus		5L	1S	
Tibialis posticus		5L	1S	
Flexor hallucis longus		5L	1S	2S
Peroneus longus and peroneus brevis	4L	5L	1S	
Gastrocnemius			1S	2S
Soleus			1S	2S
Tibialis anticus	4L	5L	1S	
Extensor hallucis longus	4L	5L	1S	
Extensor digitorum longus	4L	5L	1S	

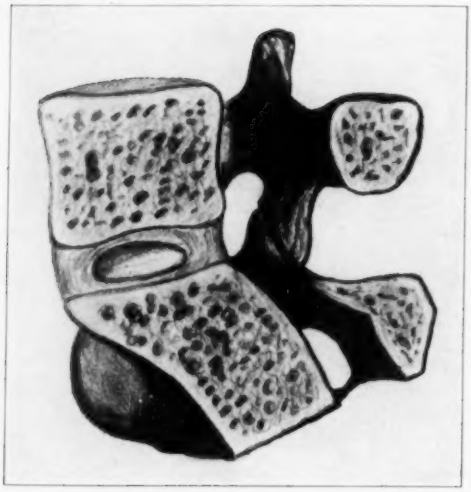

FIG. 3

Schematic drawing, showing median sagittal section of a normal lumbosacral articulation.

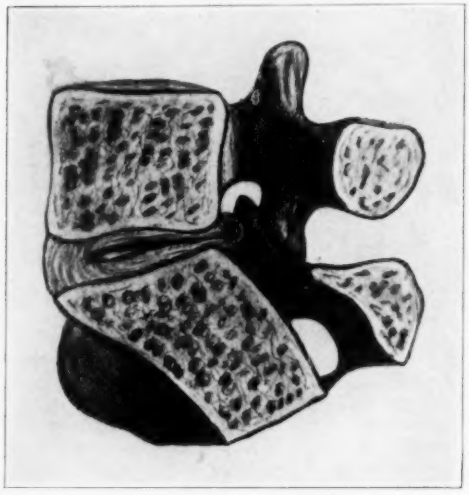

FIG. 4

Schematic drawing, showing the changes which take place following a posterior rupture of the nucleus pulposus of the lumbosacral disc. Note subluxation of facets, closure of foramen by the altered position of the first sacral facet, and the prolapse of the annulus fibrosis into the neural canal.

motor changes, there was, on the side affected, a marked paresis of all muscles of the leg except the gastrocnemius and soleus, which presented normal function.

The innervation of the leg muscles according to most of the standard textbooks are given in Table I.

It is evident from this chart that the fifth lumbar nerve is the only segment which innervates all of the muscles which were affected and not those unaffected. Since signs and symptoms are confined to this segment alone, it is logical to conclude that the irritation is proximal to the point at which the fifth lumbar nerve root joins the sciatic trunk. This corresponds closely to the conclusions of Danforth and Wilson.[2]

The fifth lumbar nerves as they emerge from the neural canal occupy approximately the upper half of the foramina and lie in contact with the anterior superior surfaces of the articular facets of the first sacral vertebra. With the subluxation which must follow a loss of the intervertebral disc, the inferior facets of the fifth lumbar vertebra move down and backward, thereby closing off the foramina and causing pressure on the nerves as they emerge. The subluxation is most severe in those cases in which the articular surfaces of the facets are in a transverse or an oblique plane. When the articular surfaces are in the anteroposterior plane the downward excursion of the inferior facets of the fifth lumbar vertebra is stopped by the superior margins of the laminae of the first sacral vertebra (Figs. 3, 4, 5, 6, 7, 8, 9, 10, and 11).

Motion at the lumbosacral joint undoubtedly greatly increases the irritation, in that flexion tends to open the foramina and thereby partially

FIG. 5

Median sagittal section of lumbosacral articulation in an anatomical specimen. Note posterior rupture of nucleus pulposus, prolapse of annulus fibrosis into neural canal, subluxation of facets, and closure of foramen. The articular surfaces of the facets in this specimen are in an anteroposterior plane.

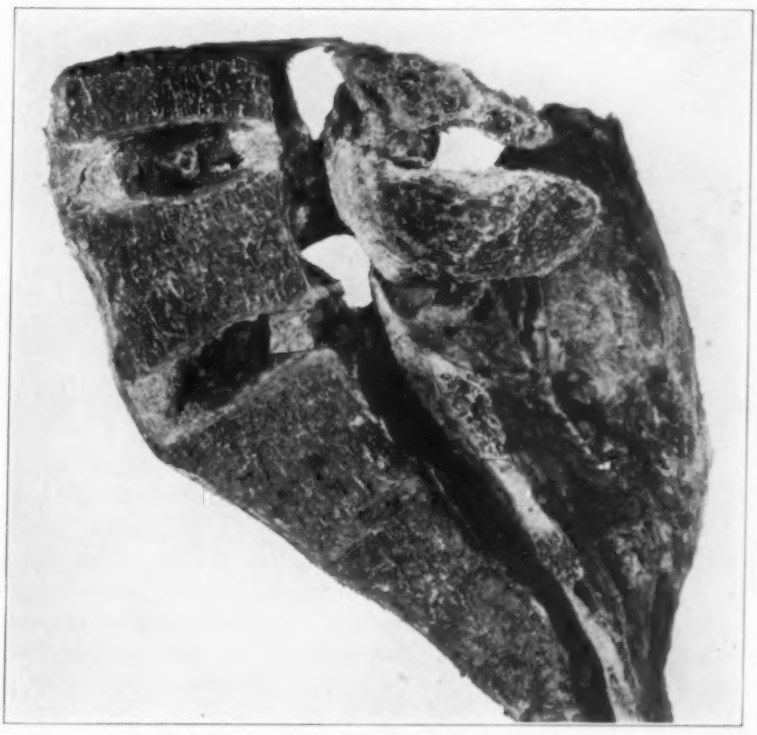

FIG. 6

Same specimen as shown in Fig. 5, with lumbosacral joint space restored posteriorly. Note increased circumference of foramen formed by the fifth lumbar and first sacral vertebrae.

FIG. 7

Roentgenogram showing lateral view of specimen shown in Fig. 5. Note that lumbosacral disc is narrowed posteriorly only.

frees the nerves, while extension causes a greater constriction of the foramina and an increased pressure on the nerves. Complete fixation of the lumbosacral joint by means of a plaster spica for a period of twelve to fifteen days will give at least temporary relief of sciatic pain in the greater percentage of cases. In a similar manner a lumbosacral fusion, by remov-

FIG. 8

Roentgenogram showing lateral view of specimen shown in Fig. 6. Note restoration of joint space.

ing the factor of motion, will give permanent relief in the majority of cases suffering with pain in the lower back and sciatic irritation. However, it is reasonable to believe that in those cases where there is a marked subluxation of the joints formed by the articular facets of the fifth lumbar and first sacral vertebral bodies, and therefore the constriction of the foramina is severe, the removal of motion alone will not relieve the irritation of the fifth lumbar nerve segments. It is our opinion that this accounts for many cases which have failed to get relief from trisacral and lumbosacral fusions.

FIG. 9

FIG. 10

Lateral views of lumbosacral spines of patients suffering with sciatica. Note loss of joint space, subluxation of facets, and closure of foramina by altered position of first sacral facets.

FIG. 11

Lateral view of a normal lumbosacral spine. Note normal appearance of the lumbosacral facets.

We advise a fusion only in persistent cases without primary neural pathological changes in which all forms of conservative treatment have failed to give relief and in which the roentgenograms show definite pathological bone changes. Thirteen such cases have been operated on during the past eighteen months. All but one have been completely relieved of symptoms. This one was a case of unusual interest.

A man, aged forty-eight, gave a history of intermittent attacks of pain in the lower part of the back, and sciatica occurring since the age of nineteen, at which time he sustained an injury to his back. Numerous attacks of such a nature had occurred as the result of lifting. For the past three years the pain had been constant and he had gradually developed a weakness of the muscles of the leg together with a numbness over the posterior lateral aspect of the calf and ankle. Symptoms were so severe that he had remained in a sitting or reclining position for the greater part of the past two years. When attempting to walk, he occasionally experienced a sudden severe lancinating pain in the extremity which would cause him to fall to his knees.

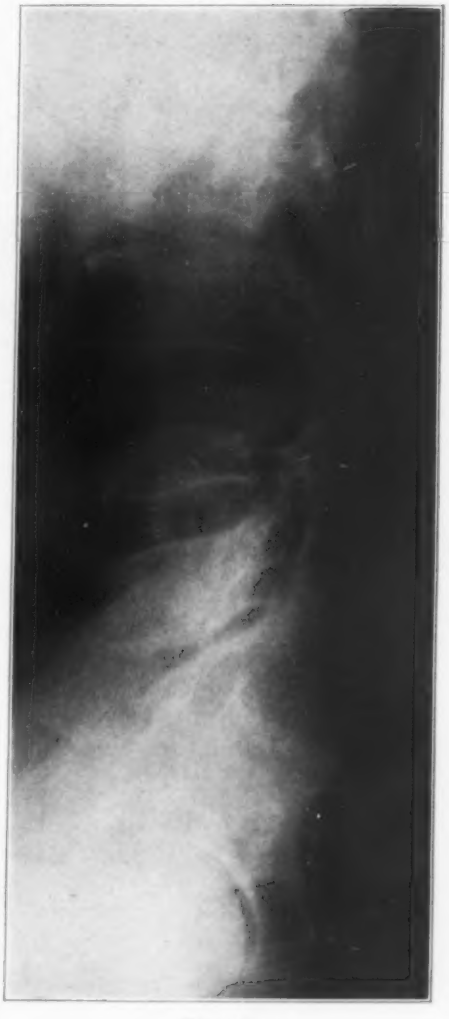

FIG. 12

Lateral view of lumbosacral spine of the case herein presented. Note arthritic reaction and narrowing of the lumbosacral intervertebral disc.

Examination revealed the findings characteristic of a severe left sciatic neuritis. There was a marked weakness of all muscles which received part of their nerve supply from the fifth lumbar segment and a hypalgesia over the area which corresponded to the sensory distribution of the fifth lumbar nerve. There was atrophy of both the thigh and calf. Spinal roentgenograms revealed a marked narrowing of the lumbosacral intervertebral disc and a localized arthritic reaction at this site (Fig. 12).

He was treated by conservative methods without appreciable relief. A lumbosacral fusion was advised and accomplished by means of a bone graft taken from the right tibia. He remained on a Bradford frame for two and a half months following operation. During his convalescence he was free from pain in the lower part of the back, but was able to elicit pain along the course of the sciatic nerve by twisting his leg into certain positions. Straight leg raising caused pain during his entire stay on the frame. After getting up he was entirely free from pain in the lower part of the back. However, the pain along the course of the left sciatic nerve persisted and was soon as severe as before the operation. Sensory and motor changes persisted. He was unable to walk more than ten to fifteen steps without sitting down, which he did by taking his weight on the right buttock and

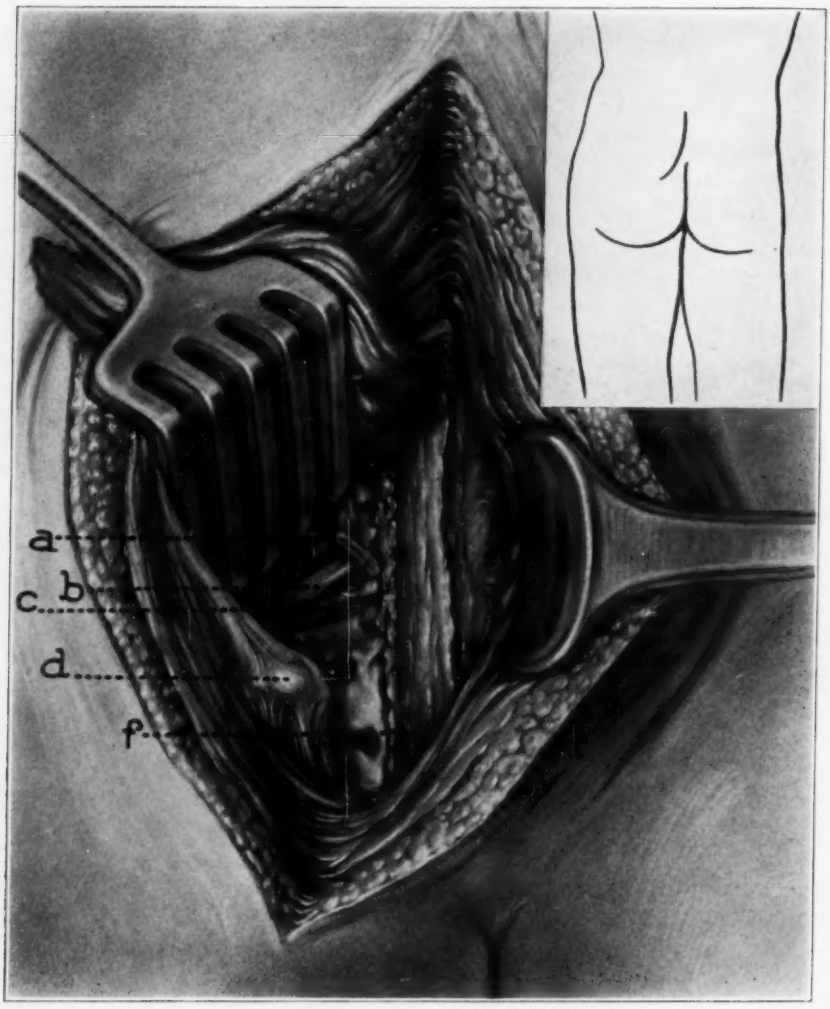

FIG. 13

Exposure of the left fifth lumbar nerve root.

a. Pedicle of left inferior facet of fifth lumbar vertebra.
b. Fifth lumbar nerve root.
c. Pedicle of left facet of first sacral vertebra.
d. Posterior-superior iliac spine.
f. Bone graft.

allowing the left hip to remain extended and the knee flexed. Conservative methods were again employed in the form of traction, epidural injections of novocain, and injection of the left fifth nerve at the point at which it emerged from the foramen, none of which gave more than temporary relief.

On the strength of our conviction that the sciatic pain was due to constriction of the foramina between the fifth lumbar and first sacral vertebrae and therefore irritation of the fifth nerve segment, an operation was planned and performed. A curved incision about six inches long and just to the left of the mid-line was made from the level of the third lumbar vertebra downward and laterally to a point about half-way between the sacro-iliac joint and the third sacral vertebral segment (Fig. 13). This permitted an exposure of the lumbodorsal fascia. The incision was continued in the mid-line until

the graft was encountered and carried down to the third sacral vertebral segment. The erector spinae muscle was dissected subperiosteally from the graft, sacrum, and posterior-superior spine of the ilium and reflected upward. This gave an exposure of the joint formed by the left lumbosacral articular facets. It was found that an excellent lumbosacral fusion had resulted from the previously placed bone graft. The joint formed by the left articular facets of the fifth lumbar and first sacral vertebrae presented a subluxation. The left inferior articular facet of the fifth lumbar vertebra was removed, affording an exposure of the articular surface of the sacral facet. This was found to be irregular and sharpened, suggestive of an arthritic reaction. The sacral facet was then removed and the fifth lumbar nerve was found to lie immediately in contact with its anterior surface. The nerve was freed from the surrounding tissues from the point at which it emerged from the neural canal to that at which it went anteriorly over the sacrum. The wound was closed in layers (Fig. 13).

Convalescence was uneventful and after two weeks the patient was allowed up. Due to his enthusiasm over the result he became rapidly ambulatory. From the time he reacted from the anaesthetic he experienced no further pain in the extremity. He was discharged four weeks after the operation with a marked return of both motor and sensory function. There was no pain to pressure at any point along the course of the nerve and the patient could walk indefinitely without discomfort.

A reexamination two months following the operation revealed a normal extremity. There was a full return of both motor and sensory function. The patient was walking from five to ten miles a day over rough ground, training his dogs for the fall hunting season. It is now eleven months since the operation and the patient is entirely free from symptoms.

From a study of approximately 500 cases of reduced lumbosacral joint space with sciatic irritation, we are convinced that the lesion in most cases is due to trauma, and the pathology is probably a rupture of the nucleus pulposus of the lumbosacral intervertebral disc. The trauma usually consists of a compression injury and for this reason the lesion is occasionally seen associated with compression fractures. The patient is usually aware of a "snapping sensation" in the lower part of the back. The pain, which as a rule follows immediately, is described by the patient as a "catch" in the back or "lumbago". Gradual relief is obtained by rest, but recurrent attacks are apt to be initiated by lifting or hyperextension injuries. The earliest symptoms of nerve-root irritation are likely to be gluteal pain and tenderness usually interpreted as sacro-iliac pathology, but which we believe to be due to irritation of the superior gluteal nerve through the fifth lumbar segment. The fibers of the superior gluteal nerve are peripherally placed within the fifth lumbar nerve root and are, therefore, the first to register irritation.

All cases should be treated conservatively. However, it is our experience that those cases showing a severe narrowing of the lumbosacral joint space with a resultant closure of the foramen and localized arthritis will eventually require surgical treatment for relief of symptoms. The tendency in this Clinic is to advise fusion earlier than has been our custom in the past. This is due principally to the fact that these patients are very apt to develop a severe psychoneurosis and not uncommonly become addicted to drugs if pain is allowed to continue without relief. It is an injustice to treat these patients by modern forms of suggestive therapy, when there is definite evidence of a lumbosacral lesion, unless methods are then instituted for treatment of their actual and primary pathological

changes. Thirty is the average age at which symptoms appear in this group of patients. If we wait for a spontaneous cure, aided by conservative methods of treatment, it means that many of these patients are doomed to semi-invalidism during the most productive period of their lives, as symptoms are likely to persist intermittently for many years under such treatment. We therefore believe that from a standpoint of economy early fusion is indicated in many cases.

If conservative treatment fails we advise a lumbosacral fusion. We are no longer doing trisacral fusions for sciatica. In those cases which show definite roentgenographic evidence of sacro-iliac pathological changes, which in this Clinic constitute less than five per cent., we advise a sacro-iliac fusion, unless there is roentgenographic evidence of associated lumbosacral pathological changes. An exposure of the fifth lumbar nerve root by removal of the lumbosacral articular facets on the side affected is advised in those cases in which there is x-ray evidence of a narrowed lumbosacral joint space and in which a lumbosacral fusion has failed to give relief. This procedure could well be carried out at the original operation; however, in so doing, one might jeopardize the health of the patient since a lumbosacral subluxation might occur if for some reason the desired lumbosacral fusion did not take place. The second operation, providing a satisfactory fusion has resulted from the first, requires but from ten to twelve days' convalescence.

Recently it has been called to our attention that Ghormley in 1931 reported a case of sciatica of two and one half years' duration, in which he enlarged the foramen of the fifth lumbar nerve by removal of a portion of the facets. Immediate and complete relief of symptoms followed.[3]

SUMMARY

1. A sciatic neuritis is usually the late stage of a sciatic neuralgia.

2. The pain in a neuralgia and the nerve changes in a neuritis are usually confined to the distribution of the fifth lumbar nerve segment.

3. The pain and nerve changes are most commonly the result of irritation of the fifth lumbar nerve root, caused by a subluxation of the articular facets of the fifth lumbar and first sacral vertebrae and, therefore, a constriction of the neural foramina formed by these bodies.

4. Fixation of the lumbosacral joint by fusion will give relief of symptoms in the vast majority of cases.

5. A lumbosacral facetectomy, after fusion had been accomplished, gave complete relief of symptoms in the one case in this series which failed to get relief from a lumbosacral fusion.

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UNUNITED ANOMALOUS EPIPHYSES OF THE INFERIOR ARTICULAR PROCESSES OF THE LUMBAR VERTEBRAE*

BY B. H. NICHOLS, M.D., AND E. L. SHIFLETT, M.D., CLEVELAND, OHIO

From The Cleveland Clinic Foundation

An ununited epiphysis of the inferior articular processes of the lumbar vertebrae, so far as we know, has not been described previously. Attention has been directed to its importance on account of the similarity to cases of fracture as described by Koch.[1]

A review of the embryological and anatomical development of the typical vertebrae does not disclose a description of a separate epiphysis for the inferior articular processes.

A detailed anatomical description of the adult vertebrae is not necessary in this paper. The anatomy of the articular processes of the lumbar vertebrae, however, should be kept in mind in order that the illustrations may be better understood. Anatomically the articular processes are well defined. The facets on the superior processes look backward and medialward and are concave; those on the inferior are directed forward and to the side and are convex. This causes the articular surface of the facets to occupy an anterior posterior plane in the lumbar vertebrae. The superior processes are farther apart than the inferior. The laminae are broad and are nearly vertical and support the inferior articular processes on their lower margins. These various characteristics are fairly well detailed on the anteroposterior roentgenogram of the lumbar vertebrae.

The reports of seven cases of anomalous formation of the inferior articular processes of the lumbar vertebrae are presented. These were discovered during routine examinations of the lumbosacral region and of the genito-urinary tract. Most of these examinations were made because of non-radiating pain in the lower back which increased with exertion. Two patients gave a definite history of trauma, but in most of the patients the back pain was not associated with injury. Two men in the group had chronic prostatitis; three were laborers doing heavy work requiring some lifting; one was a physician whose chief disability was hypertensive heart disease; and there was one woman whose chief complaint was chronic constipation and lumbago. The ages of the six men varied from twenty-five to fifty-seven years; the woman was forty years of age.

The two patients (Cases 2 and 3) who presented a definite history of trauma had other developmental abnormalities in addition to the anomaly of the inferior articular processes. One had bilateral lumbar ribs; the other, a non-fusion of the laminae of the first sacral segment, and an anomalous articulation between the fifth lumbar vertebra and the sacrum on the right side. It is significant that in the first case a diagnosis of fracture of the lumbar vertebra had been made elsewhere. When he was

*Submitted for publication November 29, 1932.

examined at the Clinic there was no evidence of any old or recent injury. This patient, therefore, was attempting to obtain compensation because of an erroneous diagnosis. The condition described was unilateral in four patients and bilateral in three. The second lumbar vertebra was involved in every case in this series.

CASE 1. A woman, aged forty years, complained of chronic constipation, recurring attacks of "lumbago" following head colds, and stiffness in the back and shoulders. The physical and laboratory examinations revealed nothing of significance except a slightly enlarged thyroid gland, and a stiff spine with moderate lower dorsal scoliosis. The lumbar spine deviated definitely to the left, and there was marked restriction of movement forward and to the left and right. The movement backward was not so

FIG. 1

Case 1. Anomaly of inferior articular process of second lumbar vertebra, bilateral.

difficult. There was considerable spasm of the muscles in the lumbar area, and marked tenderness over the third and fourth lumbar spinous processes, over each lumbosacral joint and over the right sacro-iliac joint. The patient experienced moderate discomfort on straight leg raising. Except for slight crepitation in the elbows and knees, all other joints apparently were normal.

The roentgenogram of the spine showed an anomalous, incomplete fusion of both inferior articular processes of the second lumbar vertebra (Fig. 1).

CASE 2. A man, aged twenty-five, presented himself in 1925, complaining of pain

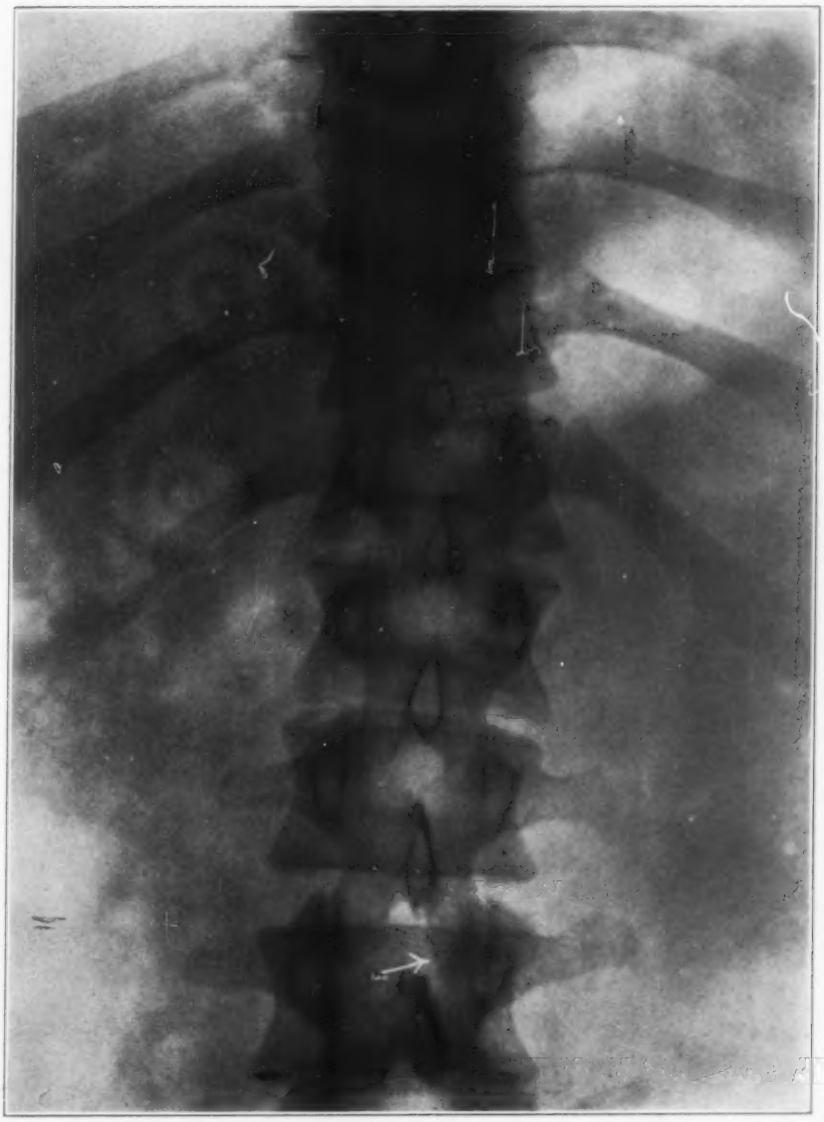

FIG. 2

Case 2. Anomaly of inferior articular process of second lumbar vertebra, left side.

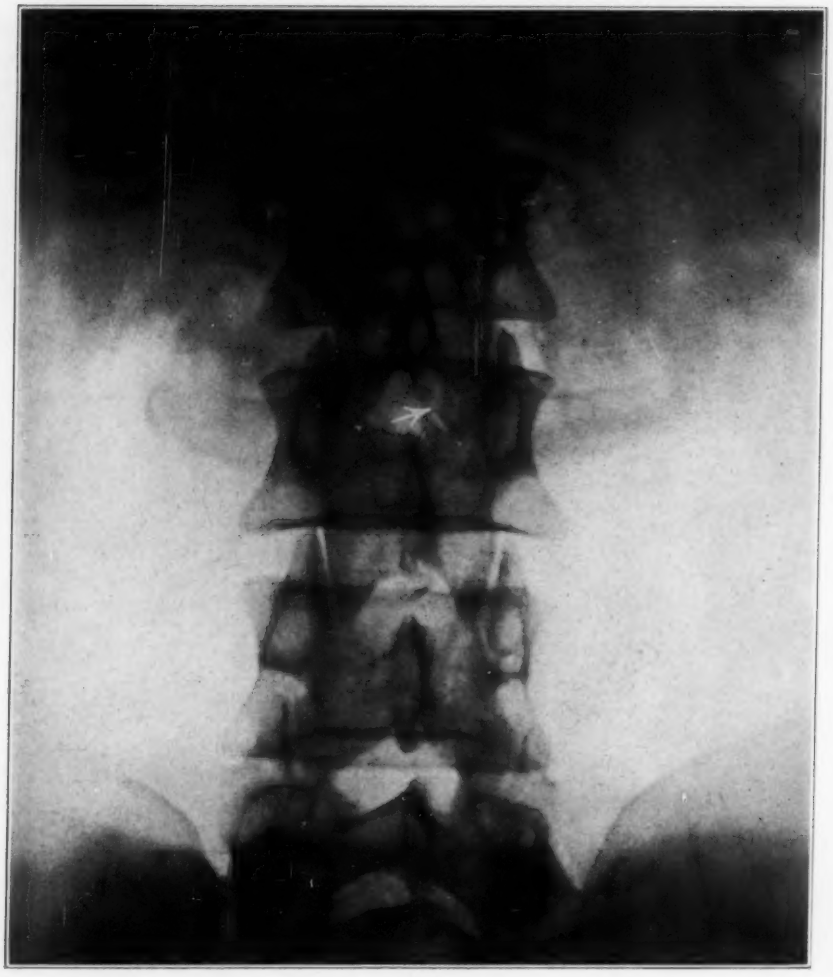

FIG. 3

Case 3. Anomaly of inferior articular process of second lumbar vertebra, left side.

in the lower back. In February 1925, while lifting one end of a bar weighing 100 pounds, he had been seized with sharp pains in the lower back which had prevented his straightening up. Some relief was afforded by having his back strapped. He was disabled for seven days and was discharged by the company physician. His pain continued and he was fitted with a brace which gave some relief. Two months later a roentgenographic examination of the spine made elsewhere was reported as negative. In June, approximately five months later, another roentgenogram at a second clinic gave evidence of fracture. He had relief at times but on exertion the dull, aching pain returned and there was occasional stiffness of the muscles in the left thigh.

The physical and laboratory examinations revealed a moderate prostatitis. There was marked lumbar lordosis with no deviation to either side; no curvatures were demonstrable clinically. Slight tenderness was elicited over the left lumbosacral joint, and over the lower spinous processes with spasm of the muscles on both sides. There was no pain on lifting the legs straight or on spreading and compression of the iliac crests.

FIG. 4

Case 4. Anomaly of inferior articular process of second lumbar vertebra, left side.

Grating was present in both knee joints, but there was no evidence of abnormality in other joints.

The roentgenogram showed an incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and bilateral ribs at the level of the first lumbar vertebra. There was a left angulation of the lower dorsal spine. The twelfth dorsal and the first lumbar vertebrae were rotated toward the right, and also were wedge-shaped with anterior apices. There was no fracture or other evidence of recent trauma (Fig. 2).

CASE 3. A laborer, aged thirty-one, was observed first in 1925 complaining of "weakness in small of back". He said that he had been thrown from a motorcycle in 1917 while in the army. He had to be relieved of duty periodically because of back discomfort. Since that time he had had persistent pain across the lower back, particularly after activity. This would disappear for two to three weeks, but bending or lifting

frequently caused return of the symptoms which were incapacitating at times. Change of position sometimes gave relief. Physical examination showed moderate lordosis of the lumbar spine with discomfort on hyperextension and considerable spasm of the muscles in the lumbar region; there was marked tenderness over the lumbosacral region and over the spinous processes of the lumbar vertebrae. The roentgenogram showed an incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and an anomaly of the last segment of the sacrum, failure of fusion of the laminae of this segment, and an anomalous lateral articulation on the right side between the fifth lumbar vertebra and the sacrum. A brace was applied to the back and the patient received considerable relief.

He returned again in 1932 for an examination required by the Veterans Bureau. He had not worn his brace for several years and his discomfort was not so severe as formerly. The lower back was moderately hollow. Movements were good and occasioned only slight discomfort on hyperextension. There was some tenderness over the fourth lumbar spinous process. The presence of the incomplete fusion previously reported was confirmed by roentgenographic examination on his second visit and showed no change in appearance (Fig. 3).

FIG. 5

Case 5. Anomaly of inferior articular process of second lumbar vertebra, right side.

CASE 4. A man, aged thirty-three, came to the Clinic in 1927, complaining of generalized stiffness and soreness, which had begun one month before in the lower back. There was a decrease in libido and the patient had some burning and frequency of urination. He attributed these symptoms to an old Neisserian infection. Physical and laboratory examinations disclosed a chronic prostatitis.

Roentgenographic examination of the lumbosacral region showed an incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and a calcified mesenteric lymph node in the mid-line opposite the fifth lumbar vertebra (Fig. 4).

CASE 5. A man, forty-four years of age, was observed first in 1931. He complained chiefly of "headaches and lumbago". The patient had always enjoyed fairly good health and was employed as a machinist, but for ten years he had had "pressing" coronal and vertex headaches. He complained of feeling tired in the morning and his memory decreased at times. He suffered from pain in the back, with muscle soreness, and his hands and feet felt cold and clammy.

Physical examination revealed a slight symmetrical enlargement of the prostate,

FIG. 6

Case 6. Anomaly of inferior articular process of second lumbar vertebra, bilateral.

FIG. 7.

Case 7. Anomaly of inferior articular process of second lumbar vertebra, right side.

a typical sacro-iliac arthritis on the right side, slight atrophy of the right thigh, and pain referred to the sacro-iliac region on straight leg raising. The roentgenogram showed some hypertrophic changes in the lumbar spine and an anomaly of the second lumbar inferior articular process on the right (Fig. 5).

CASE 6. A physician, aged fifty-six, presented himself for examination in 1931, complaining of hypertension, dizziness, and urinary difficulties. There was slight lordosis, but the patient did not complain of any pain in the back. Besides the hypertension and enlarged heart, the clinical and laboratory examinations showed gingivitis and dental caries. A roentgenogram of the kidneys, ureter, and bladder was made in

order to rule out the presence of calculi. This showed the bilateral non-fusion of the inferior articular processes of the second lumbar vertebra (Fig. 6).

CASE 7. A man, aged fifty-two, was first observed in July, 1932, complaining of fever with pus in the urine. He had had an "intestinal infection" accompanied by pus in the urine which soon disappeared. Two weeks before admission he had had a chill followed by fever which was relieved by aspirin. The following day his temperature was 102 degrees but this soon returned to a normal level. Since that time he had been free of symptoms but continued to have nocturia two to three times with burning. Physical examination revealed hemorrhoids and retention of some urine (seventy-five cubic centimeters), containing pus. A roentgenogram of the kidneys, ureter, and bladder revealed many phleboliths in the bladder area and an anomaly of the inferior articular process of the second lumbar vertebra on the right side (Fig. 7).

ROENTGENOGRAPHIC DIAGNOSIS

It is our practice to make stereoroentgenograms for the study of the spine, as this method has been found superior to examination by single anteroposterior and lateral roentgenograms.

This apparent anomaly has the characteristic appearance of an ununited epiphysis. The linear defect extends from above downward and medially, or it may be almost horizontal, bisecting the inferior articular process. The defect may extend through the facet face, or just above the base of the lamina. Each smooth edge is bordered by an apparently increased bone density as is observed in ununited epiphyses. In our experience the condition has not been observed as involving the superior articular processes.

DISCUSSION

This unusual appearance of the inferior articular processes of the lumbar vertebrae is apparently a developmental anomaly. It is impossible to determine whether it represents an anomalous ununited epiphysis or results from atypical ossification after the cartilaginous primordium has formed. Available embryological and anatomical data do not contain a description of separate epiphyseal centers for the articular processes. A roentgenographic diagnosis of ununited epiphysis, therefore, is not justified by present embryological or anatomical records. A non-fusion of the lamina which supports the process has been ruled out so far as is possible with available museum specimens. Confirmation of the roentgenographic findings by autopsy has not been possible.

The chief importance of this anomaly apparently concerns its medicolegal and economic aspect, as the condition may be diagnosed as fracture. Two of the patients reported here had been referred to the Clinic with such a diagnosis.

A review of the histories of these patients discloses no symptoms which can fairly, logically, and definitely be attributed to the specific finding. At times, apparently slight and insignificant developmental defects of the vertebral column, when aggravated by trauma, predispose to back discomfort. Injury is not always a factor, as frequently such persons complain of back discomfort when doing heavy labor, or with

increasing age and weight. Roentgenographic examination reveals no evidence of old or recent bone injury. The disability which may be caused by slight trauma in persons having congenitally unstable vertebral columns has been recognized by industrial companies; and some of them emphasize the importance of the condition to the extent of making a preliminary roentgenographic examination of the spine prerequisite to employment. Such a procedure apparently has been justified by the high incidence of anomalous conditions found in persons thus examined.

Although most of the patients in this group complained of some pain or stiffness in the lumbar or sacral region, a review of the case histories does not justify the assumption that these symptoms were due to the nonfusion of the inferior articular process of the lumbar vertebrae. The coexistence of hypertrophic arthritis or of foci of infection, such as prostatitis, and the history of back strain incident to trauma might explain all the symptoms of which these patients complained. However, it is possible that slight trauma may cause more discomfort in a patient with anomalous vertebrae than would be occasioned by the same injury in a normal person.

SUMMARY

An unexplained incomplete union of the inferior articular processes of the lumbar vertebrae is presented. This has the typical roentgenographic appearance of an ununited epiphysis. Separate epiphyses for the articular processes are not described in the present texts of embryology or anatomy or in the available literature. This condition has been illustrated and described in detail, because it may assume medicolegal significance when misinterpreted as fracture. When one becomes familiar with the typical roentgenographic appearance, the condition offers no diagnostic difficulties. We believe this is an ununited epiphysis, probably anomalous, of the inferior articular process of the lumbar vertebrae. As stated before, embryological confirmation is lacking. It seems logical to assume that the anomaly is not responsible for the symptoms present in the cases described.

We wish to express our appreciation to Harvey E. Jordan, M.D., Professor of Histology and Embryology, University of Virginia, for his kindness in reviewing his records in an effort to establish the embryological and anatomical nature of the condition described.

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FRACTURES OF THE OLECRANON

BY ERNEST M. DALAND, M.D., BOSTON, MASSACHUSETTS

From the Fracture Service of the Massachusetts General Hospital

For several years all cases of fractures treated in the wards of the Massachusetts General Hospital have been sent for at the end of a year in order to determine the end results of treatment. Patients coming to this clinic are seen by a group of men, carefully examined, any disabilities noted, and final x-rays are taken. With the old and new x-rays at hand a rating is made of the success or failure of the treatment given,—this rating based on anatomical, functional, and economic factors. For brevity these factors are spoken of as the "A", "F", and "E" end results. The degree of perfection in each group is rated on a one, two, three, or four basis; one is from no per cent. to twenty-five per cent., two from twenty-five per cent. to fifty per cent., three from fifty per cent. to seventy-five per cent., and four from seventy-five per cent. to one hundred per cent. An "A^3 F^4 E^3" result would indicate that the anatomical result based on length, alignment, apposition, and angulation was from fifty to seventy-five per cent. perfect; the functional result based on the patient's ability to use the fractured bone and the neighboring joints was seventy-five to one hundred per cent. perfect; and the economic result based on the patient's ability to do the same work for the same length of time at the same wages was fifty to seventy-five per cent. perfect.

This study is based on forty-eight cases of fracture of the olecranon. Twenty-four were treated in the House and followed for about a year. Nine cases similarly treated were not seen to determine the final result. Fifteen cases were given first-aid treatment in the Emergency Ward, but not followed in the House afterward. Data on the last group are very incomplete, so that we have eliminated these cases from detailed study.

The epiphysis of the olecranon process appears at the age of eight and becomes fused at sixteen. It is rarely separated but the normal epiphyseal line is sometimes mistaken for a fracture line. In a patient under eight a fracture line must not be mistaken for the epiphyseal line, however.

Fractures of this bone may occur at any age, but are most common in the first three decades. In our series of forty-eight cases, the ages ranged from three to sixty-nine. Eight fractures occurred in children under eight,—before the appearance of the epiphysis; eleven occurred between eight and sixteen,—before the fusion of the epiphysis to the diaphysis; and twenty-nine after fusion.

These fractures are caused by direct trauma or by falls on the outstretched hand with the elbow partially flexed. During flexion the triceps is tight and the blow is transmitted through the lower arm and the sigmoid fossa to the olecranon against the tense muscle. We have data on

the type of injury in thirty-eight cases and in these there are four instances of a direct blow to the olecranon. Ten patients fell from a height; eight fell from moving autos or motorcycles; and seventeen received their injuries by falls to the floor, street, or ice. It is uncertain how many actually fell on the outstretched hands and how many struck the elbow directly. Three fractures were compound, but two of these were given emergency treatment only. The other remained infected in spite of careful débridement, but finally healed with a good result.

Examination of an elbow in which the olecranon is fractured and the fragments separated shows localized tenderness and swelling with crepitus. It may be possible to demonstrate a cleft between the fragments. There is pain on motion at the elbow and inability to fully extend the forearm.

Many fractures of the olecranon were associated with other injuries to the bones of the same arm. The most important of these were fracture or dislocation of the head of the radius (seven cases), greenstick fracture of both bones of forearm, fracture of the coronoid process of the ulna, fracture of the lower end of the ulna, fracture of the capitellum, and fracture of the surgical neck of the humerus (two cases).

TREATMENT

Fractures of the olecranon are the only fractures about the elbow which should be treated in extension. The olecranon fossa of the humerus is just deep enough to give full extension of the arm when the ulna is of normal length and any increase in length must necessarily decrease the degree of extension. Hence complete reposition of the fragments and retention in good position are of vital importance.

In our series there were five cases where the fracture was trivial or where displacement had not occurred; so that no treatment other than a sling or a Lund swathe was needed. Four others were untreated, two because of other injuries more serious than the olecranon and two because

TABLE I

METHOD OF TREATMENT OF THIRTY-THREE HOUSE CASES

FRACTURE OF OLECRANON

	With End Results	*Without End Results*
No treatment	2	2
Plaster or bandage in extension	1	1
Manipulation and plaster	1	3
Unsuccessful manipulation and later operation—3		
Operative fixation with catgut	3	
" " " wire, nail, or bone peg	4	
" " " Kangaroo tendon	2	
" " " " " and fascial placque	4	1
" " " fascial suture	7	2
	24	9

of refusal of treatment. The other was an old fracture complicated by fracture of the head of the radius. In this case the radial head was removed but the olecranon was not treated.

Manipulation under an anaesthetic occasionally gives a good reposition of the fragments, so that fixation may be maintained by the application of plaster to the arm in extension. Of the Emergency Ward cases, seven were treated in this way, but we do not know the results. Of four House cases so treated, one is untraced; one had a good result but showed some deformity of the olecranon; a third was treated in a cast without manipulation because skin injuries made operation impossible, but a perfect result was obtained in eight weeks; a fourth sustained a refracture and an open operation was necessary. Two other cases were put up in plaster at a right angle, but the final results in these two are unknown.

Manipulation and application of a cast failed to give a proper reduction in six cases and operation was required. Six failures out of seven attempts are sufficient evidence of the inefficacy of this method.

Open operation is the proper treatment for any fracture of the olecranon in which there is any displacement of the fragments. We have tried many methods and we are now agreed that the best method is suture of the fragments with strips of fascia lata. If motion is to be started early, suture or fixation material stronger and more lasting than catgut must be used. We shall review our experiences with the different methods.

Chromic Catgut Suture

In three cases the fragments were brought into alignment by direct vision. They were held in position by chromic catgut sutures to the torn fascia and the arm placed in extension in a plaster cast. One of these fractures was compound and after débridement and suture was held by an anterior plaster splint. The arms were kept in extension for three weeks, but the casts were bivalved and massage started in about ten days. Flexion was started after three weeks. One patient returned to his regular duties as a fisherman at the end of a month. All three cases were rated as perfect end results. The period of disability in the compound fracture was three months and in the others it is not known.

The chief objection to catgut suture is the longer period of immobilization required, because of the weakness of the suture material and the danger of separation of the fragments as the catgut softens. Early motion is very much to be desired in this type of fracture and the final result depends as much on this as on the operation. Early motion cannot be started if catgut is used for the suture material.

Nails, Wire, Beef-Bone Pegs

In the effort to secure a stronger type of suture or fixative, various materials have been tried out. Three cases were treated by metal fixatives and one by a bone peg.

A boy of seventeen was operated on for a dislocation of the head of

the radius, a fractured olecranon, and a fractured ulnar shaft. The olecranon fragments were held together by four strands of Vienna braided wire. The patient returned to his former work as a shoe-machine operator, but he never regained the last ten degrees of flexion. The wire has not been removed.

A woman of thirty-one was treated by the insertion of a flanged nail through the bony fragments. She returned to full duty in five weeks and secured a perfect result. The nail has been removed.

A man of sixty-nine, suffering also from a fractured femur, was operated on under novocain and a double mattress suture of silver wire was used. A month later, under gas-oxygen anaesthesia, the wire was removed and bony union found. A week later he developed facial erysipelas, recovered, but died two months after operation of coronary thrombosis. In this case the second operation required to remove the foreign body may have been a factor contributing toward death.

A woman of fifty-two was operated on and a beef-bone peg driven through holes in the two fragments. Her disability was for three months, but she secured a perfect result.

In the case of another man of twenty-seven, heavy wire was used at a secondary operation which was necessitated by the separation of the fragments, which had been held together by kangaroo tendon. Three months later the patient fell and broke the wire. Braided bronze wire was then used together with a fascial suture. The result was satisfactory except for limited flexion.

Kangaroo Tendon

Kangaroo tendon was used alone in one other case besides the last one cited. This was in a child of five and was complicated by a fracture of the neck of the radius which was impacted. The head was replaced; the olecranon was held by two kangaroo sutures passed through the triceps tendon and the ulnar shaft; and the arm was put up at a right angle. The result was not good. A bone synostosis developed between the radius and ulna at the upper end and there was interference with growth about the elbow. Whether or not there was any lengthening of the ulna was uncertain.

Kangaroo Tendon and Fascia Lata Placque

In five cases kangaroo tendon was used as the suture material. It was passed through holes bored in the two fragments. In addition, the repaired triceps tendon was reenforced by a placque of fascia lata, sutured above and below the tear in the tendon.

A man of fifty, who developed sepsis after operation, developed a stiff elbow at one hundred degrees of extension. He was able to work regularly at his old job as a painter, but received a rating of zero for his anatomical end result.

A man of fifty-six was given an anatomical rating of three because he showed a final irregularity in the outline of the olecranon. He was able

to do his former work, although he lacked five per cent. of full extension.

A boy of nineteen returned to his work of driving a heavy truck five weeks after injury and four and one-half weeks after operation. The result was perfect.

Another boy of thirteen received a refracture after treatment in extension and was operated on according to this method with a perfect result.

The result of the other case is not known.

Active motion was allowed from the start in one case and at the end of a week in a second case. In the other cases the arms were splinted at right angles and in these motion was not started as early.

Fascia Lata Suture

Fascia lata was used as the suture material in nine instances. The use of fascia lata in this way entails no more operative work than in the method last described. The advantages are that fascia lata is a living suture of great tensile strength. Barring sepsis, it can be counted on to hold the fragments in the position where the operator places them. Early, active motion can be started without fear of complications. As a rule, motion is allowed by the third or fourth day,—as soon as the trauma of operation has disappeared.

A longitudinal incision is made over the olecranon, exposing the triceps tendon above and below the line of fracture. The skin flaps are retracted laterally, exposing the transverse tear in the triceps. The bone fragments are then exposed and any clots removed from between the ends. One drill hole (five millimeters) is made in each fragment, extending obliquely into the line of fracture and great care is taken that the articular surface is not injured. A strip of fascia lata, three centimeters by about twenty centimeters, is taken from the thigh and passed through these holes according to the technique described by Allen.[1] The fascia is rolled to enable the operator to pass it through the holes in the bones. The fragments are pulled together and the ends of the fascia are unrolled. One end of the fascia is brought through an opening in the other and the unrolled ends are sutured to the triceps fascia. In this way, retention of the fragments is secured with a living suture and also the torn triceps tendon is reenforced with a fascial graft. The wound is closed without drainage.

In examining the results of these operations, we find that a perfect rating has been given in all but one of seven cases followed to a final result. This one patient also had a fracture of the surgical neck of the humerus which responded well to treatment. However, after leaving the Hospital, he went to another where the fragments of the olecranon were removed for some unknown reason with the result that his arm was a very poor one with no motion at the elbow. He was given a fifty per cent. economic rating.

In this group we find four children between ten and sixteen, three

TABLE II

FRACTURES OF OLECRANON
END RESULTS OF TWENTY-FOUR HOUSE CASES

Case No.	Age	Method of Reduction	Fixative	Position	Disability	Rating AFE	Comments
W 276613	8	None	None	——	?	334	Untreated.
O 305174	57	"	"	——	?	333	"
W 265313	8	Manipulation	Plaster	Extension	?	344	Deformity of olecranon.
E 300855	22	None	"	"	8 weeks	344	Poor skin condition at entrance.
E 258293	30	Open operation	Chromic catgut	"	4 weeks	444	
E 264345	9	" "	"	"	12 weeks	444	Compound fracture.
O 279207	69	Manipulation, then open operation	"	"	?	444	
E 269902	17	Manipulation, later open operation	Wire	Right angle	?	344	Lacked 10 degrees of full flexion.
O 275844	31	Open operation	Flanged nail	"	5 weeks	444	
O 274887	69	" "	Wire	Neutral	——	——	Died: coronary thrombosis.
O 307270	52	" "	Bone peg	Right angle	12 weeks	444	
W 262165	27	" "	Kangaroo tendon, then wire on two occasions	Extension	40 weeks	334	Broke wire.
W 305612	5	" "	Kangaroo tendon	Neutral	?	224	Complicated by fracture of neck of radius.
W 298276	50	" "	Kangaroo tendon. Fascial placque	Right angle	14 weeks	004	Sepsis.
W 279455	56	" "	"	"	?	344	Lacked 5 degrees of full flexion and extension.
W 270736	19	" "	"	"	5 weeks	444	
E 288836	13	Manipulation and later open operation	"	Neutral	12 weeks	444	
E 266032	16	Open operation	Fascia lata suture	Right angle	8 weeks	444	
O 301712	39	" "	"	Extension	12 weeks	444	
W 267647	10	" "	"	"	?	444	
O 286011	11	" "	"	Right angle	4 weeks	444	
E 304234	61	" "	"	Neutral	4 weeks	444	
O 292387	28	" "	"	Extension	?	202	Also fracture of surgical neck of humerus. Fragments of olecranon removed at another hospital after discharge.
W 301491	14	" "	"	Right angle	3 weeks	444	

boys and a girl. Three arms were put up at a right angle after operation and the other in extension. All of these fractures were uncomplicated and the longest disability was eight weeks. Two other patients, aged thirty-nine and sixty-one, did equally well. Because of the accurate approximation and firm retention of the fragments and the early starting of motion, none of these had any limitation of motion.

The period of disability is known in five cases; it ranged from three to twelve weeks, with an average of six weeks.

Anaesthesia:

Ether was used for the primary manipulation in all the cases (seven). For the open operation the anaesthetic was ether in seventeen cases, gas oxygen, novocain, and ethylene, each twice.

Period of Disability:

The period of disability was determined in fourteen cases, and varied from three weeks to forty weeks. If we exclude the septic case and the case with two breaks of the wire suture, the average disability of the other twelve cases was seven and four-tenths weeks.

SUMMARY AND CONCLUSIONS

1. A statistical study is made of forty-eight cases of fracture of the olecranon with end-result studies in twenty-four. Fifteen of these cases were treated in the Emergency Ward and were not admitted to the House.

2. Closed reduction of these fractures has been very unsatisfactory and we believe that it is not worth attempting. Open operation is indicated whenever there is any separation of the bone fragments.

3. The results of open operation by any one of five methods have been universally satisfactory. The only unsatisfactory cases have been one complicated by postoperative sepsis and another complicated by an ill-advised secondary operation done elsewhere. The operation calls for exact reposition of the fragments and fixation by catgut, wire, kangaroo tendon, nails, pegs, or fascia lata. The use of foreign bodies as fixatives means secondary operations for their removal.

4. The operative mortality was four and three-tenths per cent. in the twenty-three cases on whom open operations were done.

5. There is no relation between the age groups or the degree of development of the epiphysis and the final result.

6. From our tabulated results it is not possible to demonstrate any quicker recovery from the use of any one material, but from personal observation we are convinced that function returns faster and the final elbow is stronger when fascia lata is used as a living suture to hold the fragments together. This is the method now in use at this hospital and the method which we wish to recommend.

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ISOLATED FRACTURES OF THE ARTICULAR PROCESSES OF THE LUMBAR VERTEBRAE *

BY C. LESLIE MITCHELL, M.D., DETROIT, MICHIGAN

Although fractures of the articular processes, associated with severe fractures and fracture dislocations of the vertebrae, are frequently seen and reported, very little mention has been made in the literature of an isolated fracture of this process. The present series of cases observed in a comparatively short period of time leads the writer to the belief that the fracture is not at all uncommon and frequently accounts for long-continued back symptoms following a severe injury.

Since the first case came under the writer's observation early in 1929, he has been constantly on the lookout for this type of fracture, particularly in those patients who have had a severe back injury, apparently negative roentgenographic findings, and yet prolonged symptoms that did not respond to the usual treatment for low back sprain. In several cases it was only after repeated x-ray films from different angles and with finer detail that the lesion was discovered. Of the present series of five cases, four were personally observed by the writer and the other is reported through the courtesy of Dr. C. W. Brainard of Battle Creek, Michigan.

Brief mention of this fracture is made in the literature and in textbooks by many different authors, but there are very few specific cases cited. Burk [1], in 1908, reported a fracture of the superior articular process of the fifth lumbar vertebra. Koch [2], in 1923, brought the literature up to date in a report of a single case with a fracture of the inferior articular process of the fourth lumbar vertebra and the superior process of the fifth.

The fractures observed in this series have all involved the processes of the lumbar vertebrae, but it is conceivable that a similar lesion of the thoracic and cervical vertebrae could occur. The difficulty in obtaining satisfactory roentgenographic detail of the processes of the latter vertebrae may account for the non-recognition of similar fractures there. Anatomically, however, there is much greater chance for these fractures to occur in the lumbar spine than elsewhere.

It is the writer's opinion that these fractures occur as a result of indirect violence. A severe force, causing the spine to be flexed both forward and laterally and at the same time rotated, produces impingement of the subjacent articular processes. The capsules, which are attached to the margins of the articular processes, are placed under considerable tension. If the force is sufficient, the combined action of impingement and capsular pull will produce a fracture of the tip of one or both of the subjacent processes.

An interesting feature in all of the cases observed is the persistent nonunion of the fragments with no attempt at callus formation. This has

* From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit.

been the observation of all writers on the subject. It is possible that incomplete immobilization of the fragments and the presence of synovial fluid may account for this failure of bony union. All of the fractures observed in this series, and by other writers, have been recognized late following the injury, and to the writer's knowledge there is no report of an early diagnosis with complete immobilization.

It might be argued that these lesions do not represent fractures but rather developmental anomalies with failure of union between the primary and secondary epiphyseal centers. According to McMurrich[3], secondary centers of ossification appear at puberty in the cartilage at the tips of the articular processes. These epiphyses remain separate until growth is complete and between the sixteenth and twenty-first years unite with the bone from the primary center. No such anomalous lesion has, to the writer's knowledge, been described in the literature. Willis[4], in a study of 1471 skeletons in regard to vertebral anomalies, does not mention this lesion. Furthermore, one would expect to encounter this lesion quite frequently in routine roentgenograms of the spine, but we have no knowledge of its occurrence without a history of severe trauma. There was point tenderness over the fractured processes in all of the cases observed. Three of the cases in this series presented double lesions and these were all unilateral, suggesting a traumatic etiology. Trauma as an etiological factor is again suggested by the fact that all five patients were males. In the case operated upon by the writer, the processes were exposed and fibrous tissue union found between the fragments. Microscopic study of the intervening tissues showed no evidence of cartilage, as would be expected with a failure of union between the epiphyses.

Eight fractured processes are included in this series as three patients exhibited double lesions. An analysis of the lesions reveals that five of the fractures involved inferior processes. The processes of the second, third, and fourth lumbar vertebrae only were involved, possibly due to limited mobility in this region as compared with the dorsolumbar and lumbosacral joints. The location of the fracture line varied from three-tenths to one and two-tenths centimeters in distance from the tip of the process.

Conservative treatment gave satisfactory results with three patients who were first observed some months following injury. Treatment consisted of a short period of recumbency, followed by physiotherapy and the application of a support,—such as a canvas belt or a Goldthwait back brace.

Two patients did not respond to conservative treatment and in these cases a spinal fusion was performed. At operation the involved processes were exposed, the fractured tips and the cartilage of the facets removed, and a tibial graft placed between the split spinous processes. Immediate relief of symptoms was noted in both cases following operation; and one patient (W. C.) has had no recurrence of symptoms ten months later. The other patient (H. W.) has remained symptom-free since his operation three months ago.

CASE REPORTS

CASE 1. Mr. W. C., thirty-nine years old, was injured on November 24, 1928, while unloading lumber from a flat car. He was struck by a crane load of lumber and knocked off the car, falling ten feet to the ground, and landing on his left side. He was brought to the hospital by ambulance and seen by the writer on admission. His symptoms were referred to the left hip and roentgenographic examination revealed an intertrochanteric fracture of the femur without displacement.

In February, 1929, when commencing to walk, he complained for the first time of

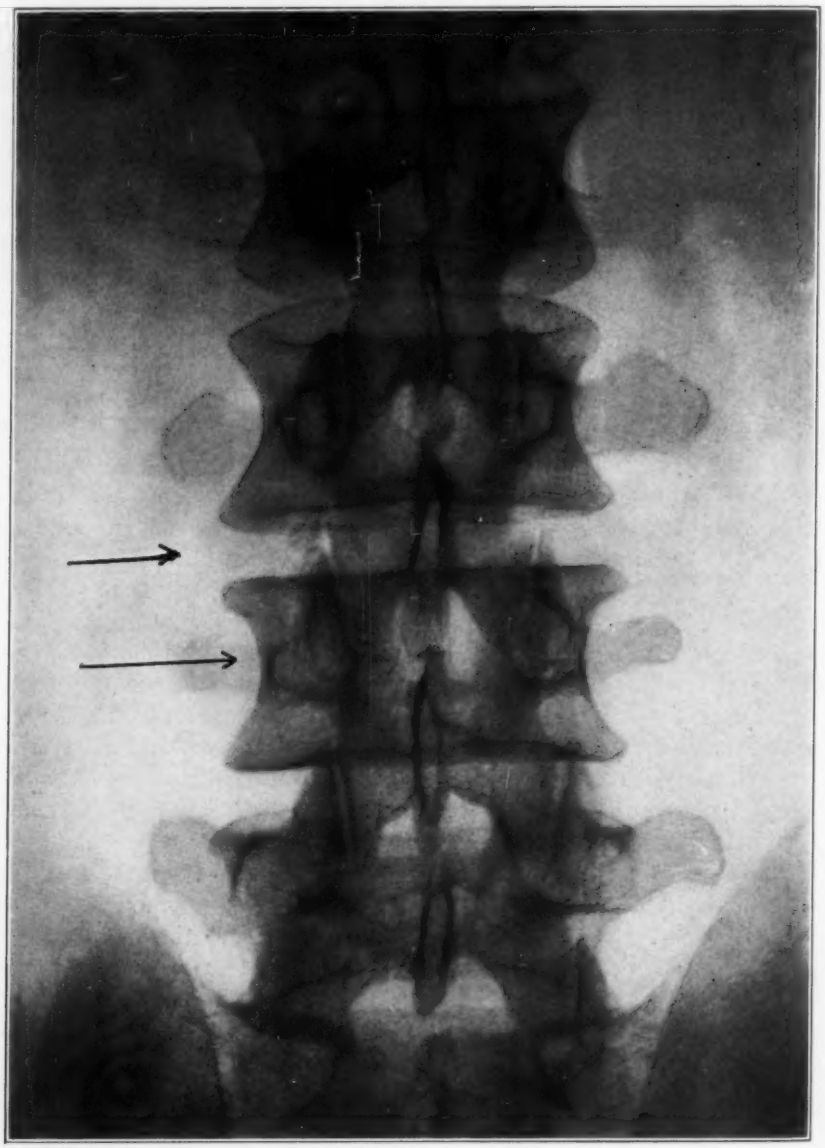

FIG. 1
Case 1.

symptoms in the low back region. Examination of the spine revealed moderate restriction of motion of the lumbar spine in all directions and it was found that forward flexion and rotation counter-clockwise produced pain, referred to the right side of the spine at the level of the third and fourth lumbar vertebrae.

Roentgenograms were taken of the lumbar spine and pelvis and no evidence of pathology was found. A diagnosis of low back strain was made and the patient treated with physiotherapy and a lumbosacral belt. Because of continuation of symptoms, detailed roentgenograms of the lumbar spine were repeated on April 24, and these revealed a fracture of the superior articular process of the fourth and the inferior process of the third lumbar vertebrae on the right side.

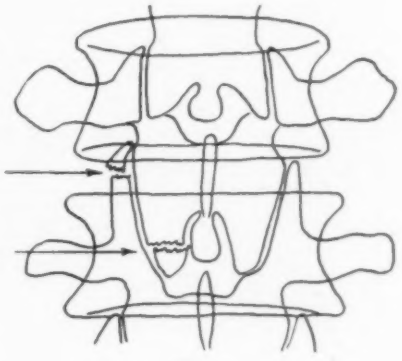

FIG. 2

Case 1. Schematic drawing of Fig. 1.

A Taylor back brace was applied and physiotherapy to this region continued. He returned to light work in May, 1929. Progress roentgenograms, taken at intervals until February, 1931, revealed no evidence of callus formation and the patient continued to complain of discomfort in this region. Operative fusion of this area was advised and performed on May 14, 1931.

At operation, the laminae and articular processes of the third and fourth lumbar vertebrae were exposed. The tips of the superior process of the fourth and of the inferior process of the third on the right side were easily visualized and found to be partially detached. There was fibrous tissue only between the fragments and no evidence of callus or cartilage. The fractured tips were excised, the cartilage from the articular surfaces removed, and an Albee fusion of the second, third, fourth, and fifth lumbar vertebrae carried out. Microscopic examination of the tissue between the fragments revealed fibrous tissue only and no evidence of cartilage.

Patient had complete relief from back symptoms following the operation. He was allowed up in June and had no further trouble until September, when he reported back with recurrence of symptoms. On examination it was found that the distal portion of the graft had become loose. The spine was re-fused in March, 1932, and he has remained symptom-free since then.

CASE 2. Mr. N. W., seventeen years of age, was admitted to the hospital on May 21, 1931. Three months previously he had injured his back in a fall of about six feet from a trapeze bar. He had noticed pain in the back for several weeks following the accident, but was not disabled. On several occasions since then he had experienced pain in this region after severe exercise, usually accompanied by pain in the right lower abdominal quadrant.

He was admitted on the General Surgical Service with a complaint of pain in the right lower abdominal quadrant of two days' duration. For the past six hours he had also noticed pain in the low back region. There was no history of nausea or vomiting. Temperature was 98.8 degrees; white blood cells 8,350. Urinalysis was negative. There was tenderness in the right lower abdominal quadrant but no muscle spasm.

Roentgenograms of the lumbar spine revealed fragmentation of the left inferior processes of the second and third lumbar vertebrae. Examination of the spine showed flattening of the lumbar curve, marked limitation of motion of the lumbar spine, and tenderness on pressure over the laminae of the second and third lumbar vertebrae on the left side. Pain in the back was produced by forward flexion and rotation of the spine clockwise.

Appendectomy was performed on May 23, with a pathological report of chronic appendicitis. A Taylor back brace was applied prior to discharge from the hospital on

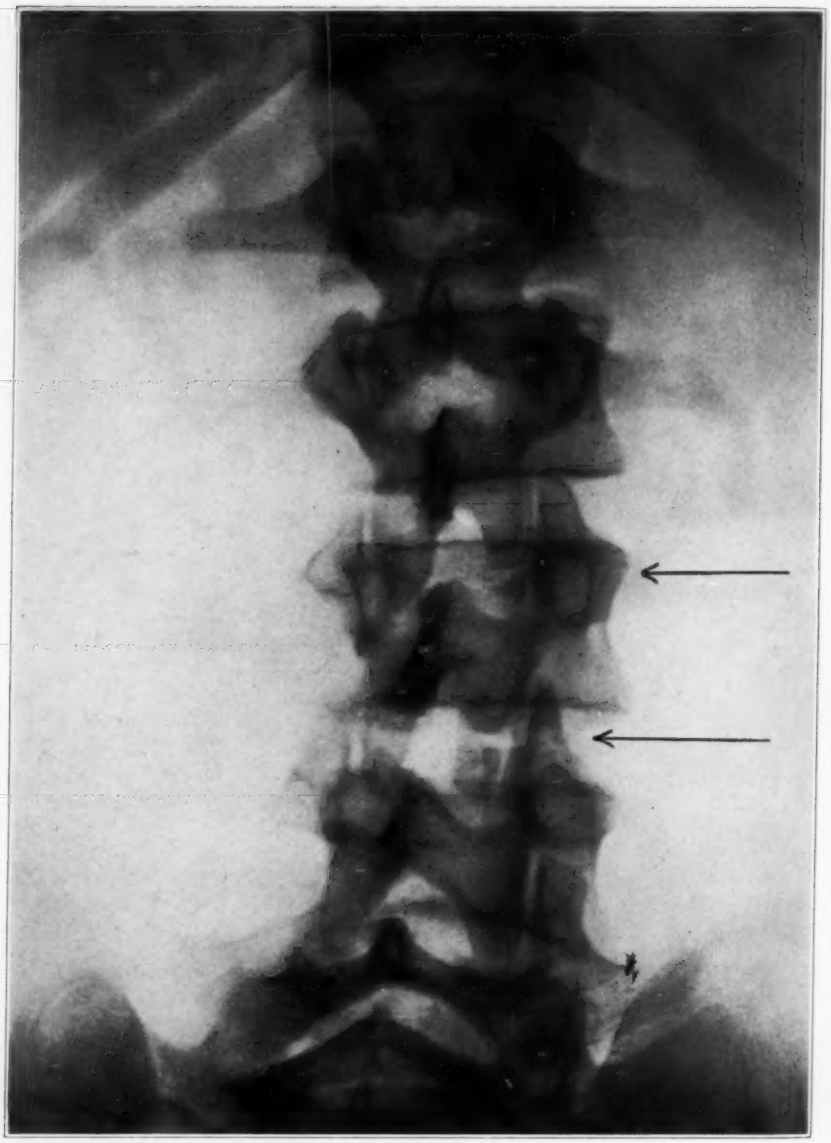

FIG. 3
Case 2.

June 7. When he was last seen in October, 1932, the spine was symptom-free but there was still palpatory tenderness over the fractured processes. Progress roentgenograms revealed no evidence of callus formation.

CASE 3. Mr. F. D., forty-five years of age, was first seen in the hospital in October, 1926. He gave a history of a severe injury to his spine twenty years previously with disability for about three weeks. Since that time he had had recurrent attacks of acute low back discomfort at irregular intervals, always following severe exertion.

Examination revealed a total list of the spine to the left, flattening of the lumbar spine, with spasm of the erector spinae muscles in this region. There was tenderness to percussion over the upper lumbar vertebrae. Roentgenograms were advised, but refused by the patient. A diagnosis of acute lumbosacral strain was made and adhesive strapping applied with relief from symptoms in about three days' time. In June, 1930, he reported back with similar symptoms and findings. Adhesive strapping gave relief from symptoms in a few days' time.

He was seen by the writer in April, 1932, with a complaint of symptoms in the low back of three months' duration. The symptoms had occurred suddenly at that time while lifting a hundred-pound sack of flour. Examination revealed a total list of the spine to the left, flattening of the lumbar spine with muscle spasm, and point tenderness over the lamina of the second lumbar vertebra on the right side. Roentgenograms showed a fracture of the right inferior articular process of the second lumbar vertebra. The fracture line was smooth and there was no evidence of callus formation.

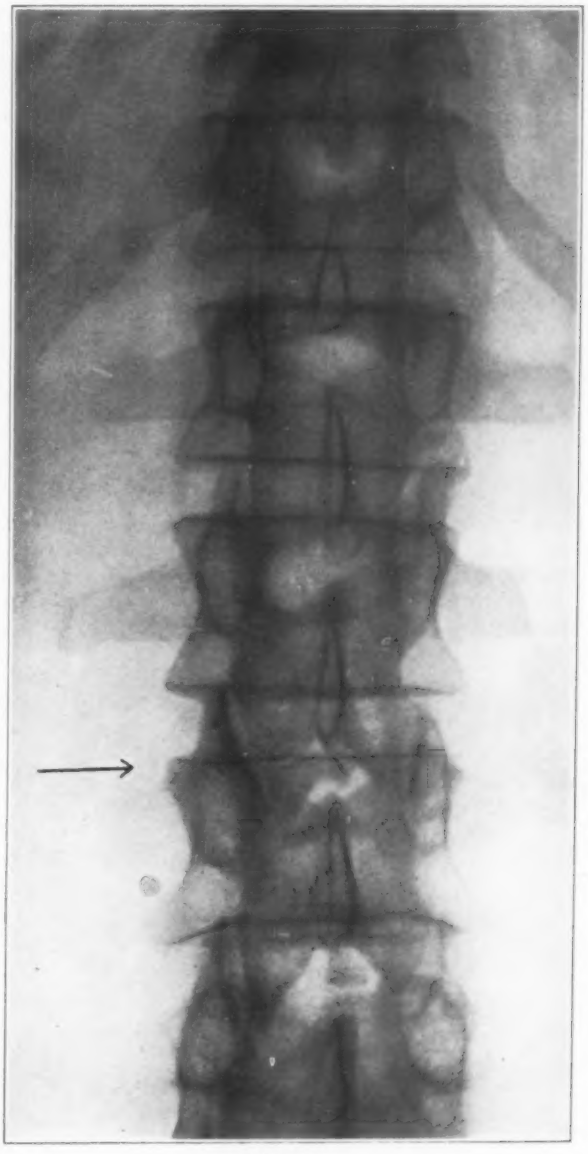

FIG. 4
Case 3.

A Goldthwait back brace was applied with complete relief from symptoms one week later. A recent letter from the patient states that he has had no recurrence of symptoms since then.

CASE 4. Mr. H. W. (Dr. Brainard's case), truck driver, twenty-five years of age. On February 3, 1932, while lifting a bag of sugar, weighing 100 pounds, from a truck, he slipped on the ice and fell with the bag of sugar striking on his back and right side, about the level of the upper lumbar vertebrae. He noticed back pain immediately but continued at his work, although he was unable to do any heavy lifting. However, his back became increasingly painful and he was seen by Dr. Brainard on February 25.

Examination revealed a list of the spine to the right with flattening of the lumbar curve and spasm of the lumbar erector spinae muscles. Flexion of the spine was possible upon encouragement, with pain always referred to the region of the second lumbar vertebra on the right side. There was tenderness to percussion over this area. Examination by x-ray revealed a fracture involving the right inferior articular process of the second lumbar vertebra.

He was treated by recumbency on a Bradford frame for six weeks. Progress roentgenograms showed no evidence of callus at the fracture site. A Taylor back brace was applied and he was gradually allowed up and about. Because of persistent pain, operation was performed on November 16, 1932. An arthrodesis of the involved articulations was carried out, the fractured tip removed, and a tibial graft placed between the split spinous processes of the second, third, and fourth lumbar vertebrae.

He has been quite comfortable since the operation and the pain, of which he had complained since the accident, has entirely disappeared.

CASE 5. Mr. C. D., twenty-six years of age, was injured on September 25, 1931. A tractor, which he was driving, upset and he was struck forcibly in the right lumbar region by one of the fenders. He was taken to a hospital in Ypsilanti, where he remained in bed for two weeks. Roentgenograms were taken of the lumbar spine and reported negative for fracture. Following his discharge from the hospital, he continued to notice pain in the low back and was unable to return to work. He received some relief with physiotherapy and adhesive strapping, which were given him at intervals for a year.

He was referred to the Henry Ford Hospital for examination on December 1, 1932. He was complaining of pain in the right lumbar region, which was noticed with any bending or twisting of the spine. Examination revealed a slight list of the spine to the right and some loss of the lumbar curve. There was no muscle spasm and forward flexion was not limited, but was carried out guardedly by the patient. Lateral flexion to the left produced pain, referred to the right side at the level of the second lumbar vertebra. There was tenderness to pressure over the articular processes of the second and fourth lumbar vertebrae on the right side. Roentgenograms revealed fractures of the right superior processes of the second and fourth lumbar vertebrae.

A Goldthwait brace was applied and operative fusion recommended, if his symptoms continued. He reported two weeks later, having noticed moderate improvement in symptoms, and has not been seen since then.

SUMMARY

1. Attention is called to the isolated fractures of the articular processes of the lumbar vertebrae.

2. This fracture is frequently unrecognized because of imperfect roentgenographic detail, and the patient is frequently treated for low back strain.

3. The possibility of this condition representing a developmental lesion is discussed.

4. For those cases that do not respond to conservative treatment, operation is advised, including spinal fusion, arthrodesis of the involved joint, and removal of the fractured fragments.

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ROENTGENOGRAPHIC FINDINGS IN ACUTE GONOCOCCAL SYNOVITIS OF THE KNEE TREATED BY PNEUMARTHROSIS

A Report of Two Cases with a Plea for Early Motion *

BY SIDNEY GINSBERG, M.D., NEW YORK, N. Y.

The introduction of gas into the knee for the purpose of aiding the roentgenographic diagnosis of disorders of that joint has been utilized by a number of writers. Cases of injured semilunar cartilage in which the diagnosis was facilitated by such procedure were reported by Kleinberg [1, 2] and Rechtman [3]. Krida [4] described a case of chronic synovial hyper-

Fig. 1

Case 1. Roentgenogram during the height of the first effusion. The effusion, which subsequently forms the organized prefemoral mound, is seen lying against the femur in the ballooned suprapatellar pouch. No air is observed in the posterior joint space and but little in the lateral aspects of the suprapatellar pouch. The ligamentum mucosum is excellently outlined. Due to the accidental injection of air into the soft tissues, the patellar ligament and quadriceps tendon are well visualized.

* From the Third Surgical Division of Bellevue Hospital, Dr. Arthur M. Wright, Director; and from the Orthopaedic Service of Dr. H. Finkelstein, Hospital For Joint Diseases.

FIG. 2

Case 1. Roentgenogram at end of the first effusion and during the period of immobilization. The increased density of the effusion in the posterior portion of the suprapatellar pouch suggests beginning organization. As yet no air is visualized in the popliteal bursa or in the lateral aspects of the suprapatellar pouch.

trophy of the suprapatellar pouch, the recognition of which was aided by this method. Oxygen was the gas used by these men.

Others have reported the therapeutic insufflation of gas in the treatment of disease of this joint. Rost [5] mentioned five cases of tuberculosis of the knee with good functional results following irrigation and oxygen inflation. Porter and Rucker [6] presented five cases of acute gonococcal synovitis with no functional limitation after treatment by air injection. A case of limitation of motion at the knee following rheumatic polyarthritis treated in like manner by Henson[7] showed great improvement.

In two cases of acute gonococcal synovitis of the knee joint treated by us, in a manner modifying the procedure of Porter and Rucker, interesting roentgenographic findings were discovered. These indicate an exact anatomical cause of the functional impairment often following this condition and suggest radical changes in the heretofore accepted treatment of the disease.

These cases were observed concurrently. The effusion in Case 1 was continuous for five days and then, after seventeen days of quiescence, recurred for three days more. In Case 2 the effusion was continuous for

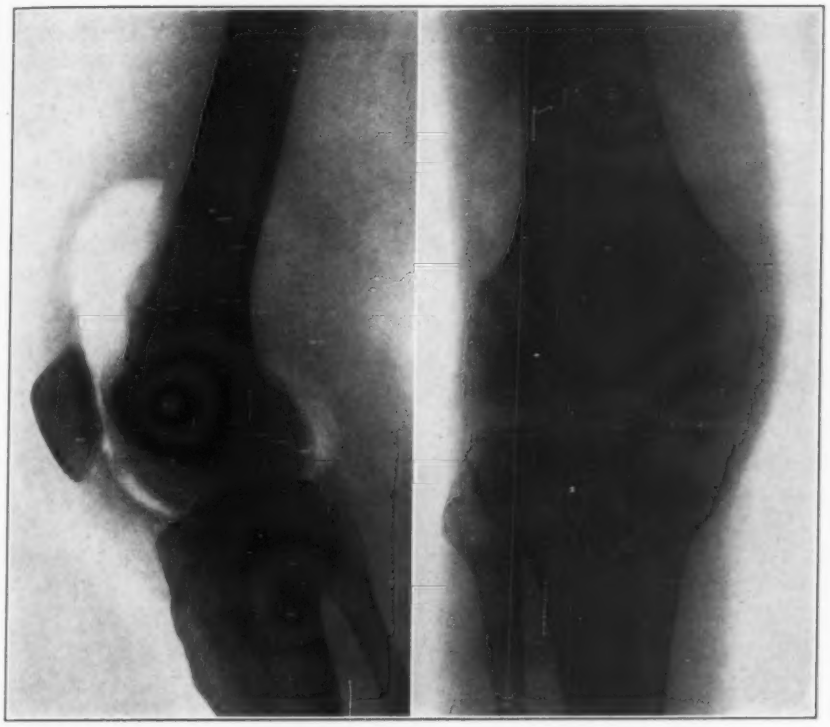

FIG. 3

Case 1. Roentgenogram after subsidence of the second effusion and during the period of active motion. The adhesion between the anterolateral aspect of the suprapatellar pouch and the prefemoral mound of organized effusion is clearly shown. The posterior joint space and lateral aspects of the suprapatellar bursa are ballooned by the injected air for the first time.

twenty-three days. Treatment was instituted in both cases within three days of the inception of the disease. The joints were aspirated and inflated with from 120 to 140 cubic centimeters of air daily for as long as the effusion tended to recur. In Case 2, owing to the gelatinous consistency of the effusion, the treatment was supplemented by daily irrigation of the joint with warm saline solution.

No attempt was made either to sterilize or filter the injected air, since no untoward results had been reported in similar instances, nor in the intraspinal injection of air used in encephalography. Injection was performed by means of an aspirating needle and a twenty-cubic-centimeter glass syringe, with a length of rubber tubing interposed between. The application of an artery clamp was sufficient to seal the tubing while the syringe was withdrawn for refilling with atmospheric air. Porter and Rucker utilized a two-way needle connected by tubing to the mercury column and bulb of the sphygmomanometer; while Berg [8] modified their apparatus by interposing an air-cleansing chamber between the bulb and needle.

In accordance with the accepted custom, the joints were immobilized in extension for the first week. However, a careful study of the roentgenograms at that time persuaded us to remove such immobilization, to encourage active motion, and to further aid it by exercising in daily warm baths.

Case 1 was discharged in thirty-one days with no pain, extension to 180 degrees, and flexion to 70 degrees. Case 2 left the hospital in twenty-five days with but slight residual soreness, extension to 180 degrees, and flexion to 80 degrees.

The involved joints were roentgenographed at approximately weekly intervals. During the period of immobilization, these plates revealed mixed air and effusion in the suprapatellar pouch and anterior portion of the joint space proper, the effusion being especially pronounced in the posterior portion of the pouch. At no time during this period was either the popliteal bursa or the lateral aspects of the suprapatellar pouch ballooned by the injected air.

Roentgenograms taken during the period of active motion showed a prefemoral mound of organized effusion in the posterior portion of the

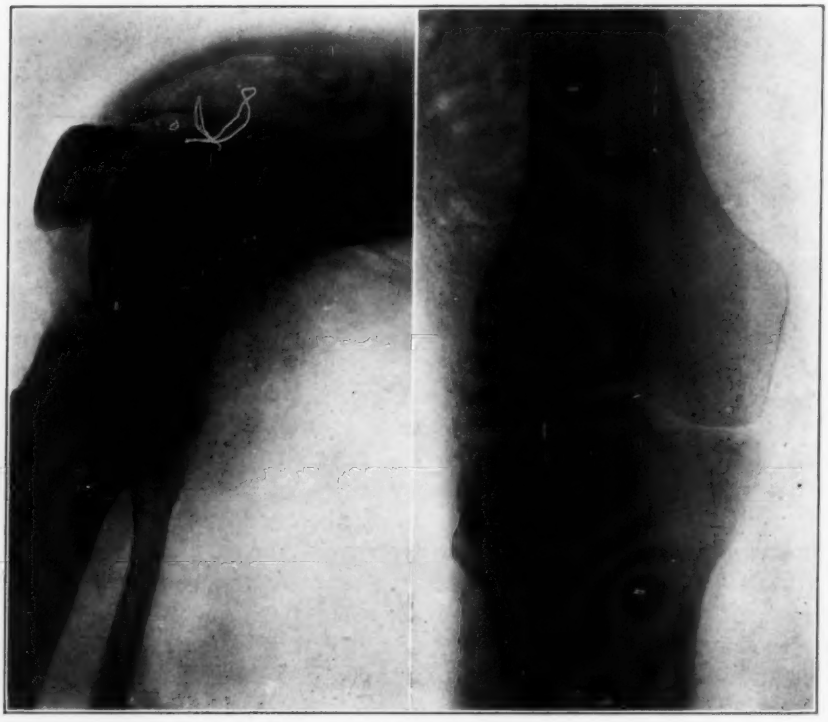

FIG. 4

Case 2. Roentgenogram at onset of the effusion. Mixed air and effusion are noted in the anterior joint space and suprapatellar pouch. The popliteal pouch is not visualized, nor are the lateral aspects of the suprapatellar pouch more than slightly outlined.

suprapatellar bursa and adhesions between it and the anterolateral aspects of the bursa. The popliteal bursa and lateral aspects of the suprapatellar pouch were ballooned by the injected air and, therefore, visualized during this period.

From a study of these plates, the course and sequelae of the synovitis were considered to be as follows:

1. The inflamed synovia produced an effusion which filled all of the joint spaces.

2. Some of this effusion escaped absorption, irrigation, and repeated aspiration, and became static in the dependent portions of the suprapatellar pouch and the joint proper during the period of immobilization. It soon became organized following invasion by fibroblasts and new blood vessels from the adjoining inflamed synovia.

3. Air insufflation separated this organizing effusion from apposing joint surfaces for the most part.

4. During the period of active motion fine adhesions in the joint space proper were rubbed free, while those in the pouch, being less affected by joint motion, were less molested and, therefore, allowed to become firmly organized.

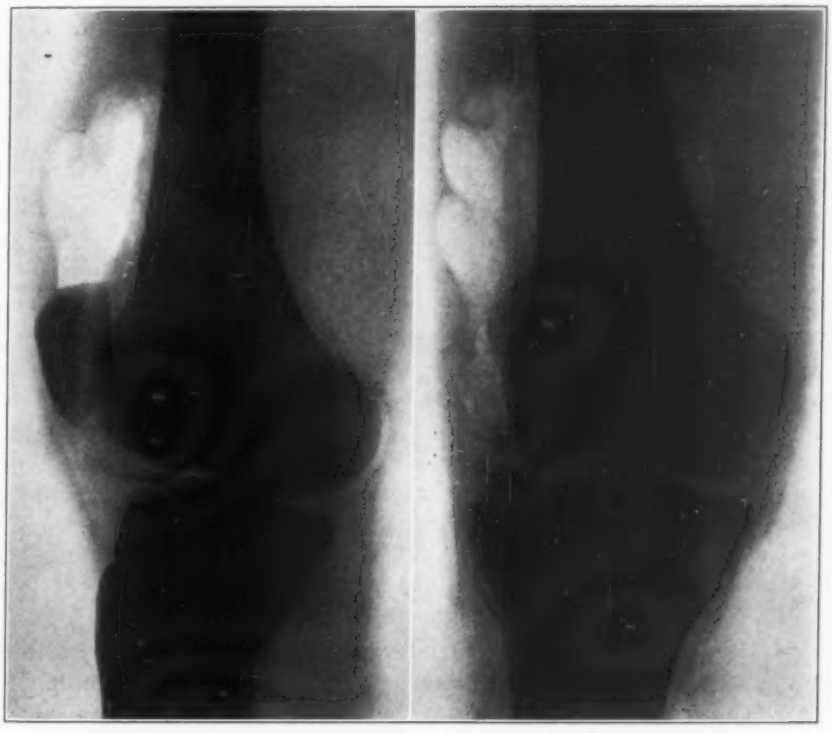

FIG. 5

Case 2. Roentgenogram following a week of active motion. The margins of the suprapatellar pouch are indented in numerous places by the adhesions between it and the prefemoral mound of organized effusion. The popliteal bursa is clearly outlined by the injected air.

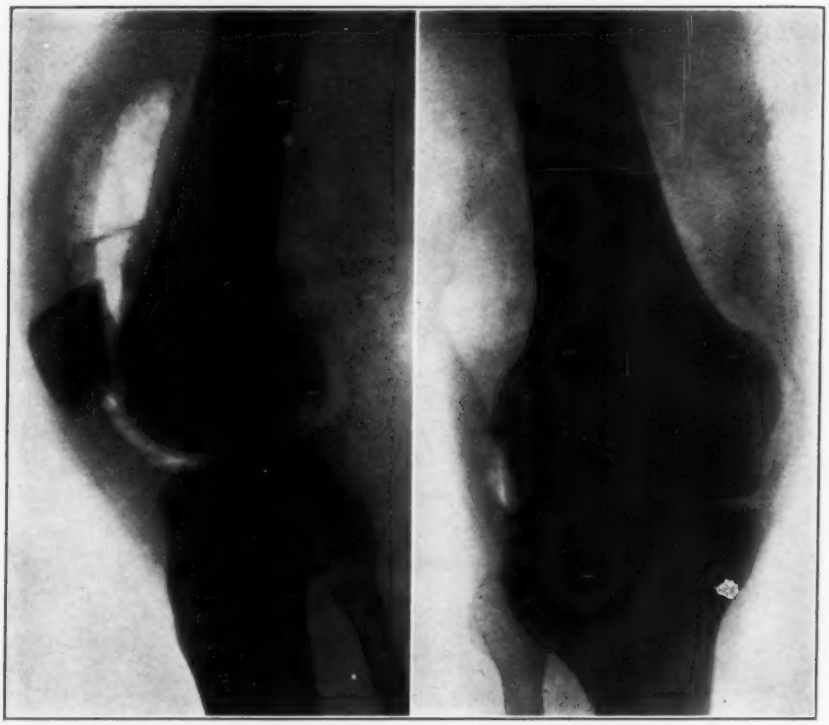

FIG. 6

Case 2. Roentgenogram after complete subsidence of the effusion and two weeks following the institution of active motion. The changes observed are essentially those shown in Fig. 5, except that the outlines of the suprapatellar pouch are more evenly outlined.

5. The limitation of flexion in these cases was due to interference with complete lengthening of the quadriceps tendon by the adhesions between it and the prefemoral mound of effusion.

In view of the trend of events mentioned, it appears advisable in the treatment of inflammatory effusions into the knee joint to forsake the time-honored procedure of immobilization, and, instead, to institute motion immediately in order to prevent potentially-organizing static effusions. Frequent aspiration and irrigation, to minimize the amount of effusion, and frequent air inflation, to separate the inflamed synovial surfaces, also appear to be rational aids in treatment.

CONCLUSIONS

1. In two cases of acute gonococcal synovitis of the knee, treated by a short period of immobilization and daily aspiration and air inflation, the patients recovered, with good functional results, in an average period of four weeks.

2. Roentgenograms taken of the air-filled joints revealed characteristic adhesions in the suprapatellar pouch, which account for the slight functional impairment encountered in these cases.

3. The sequelae of the effusion, as revealed by these roentgenograms, suggest that early motion and frequent aspiration and air inflation are valuable adjuncts in the intelligent treatment of this disease.

The author wishes to express his indebtedness to Dr. Arthur M. Wright, Director of the Third Surgical Division of Bellevue Hospital, without whose aid and inspiring encouragement this paper could not have been written.

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SPINAL FUSION BY SIMPLIFIED TECHNIQUE

BY MYRON O. HENRY, M.D., AND EMIL S. GEIST, M.D.,
MINNEAPOLIS, MINNESOTA

The following technique for fusion of the spine has been developed and used by the authors during the past nine years. It is a modification of the Hibbs method which can be carefully done in forty to fifty minutes by having a second operating team to remove the grafts. Multiple chip grafts are taken from the upper end of the tibia, which provides both cortical and cancellous bone; and the spinal bed is prepared by hand chisels without hammering. Complete and solid fusion is obtained by this method, and there is little or no danger of shock. Satisfactory results have been obtained in over seventy-five cases.

TECHNIQUE OF OPERATION

The patient is prepared for operation in the usual manner. Shoulder rests (Fig. 2) are used to raise the chest slightly from the operating table, so as not to embarrass respiration during the operation. A mid-line incision, at least twelve inches in length, is made, centering over the area to be fused. The cut edges of the skin are iodized, as advocated by Naughton Dunn, before being walled off with towels.

With a sharp scalpel the fascia and the supraspinal ligaments are incised longitudinally, together with a portion of the interspinal ligaments, in order to freely expose the tips of the spinous processes. At least two segments above and below the affected area are fused, and therefore seven or eight spinous processes must be exposed. Next, with a broad raspatory (Fig. 1) the periosteum and muscles *en masse* are scraped off the spinous processes and laminae as far laterally as the articulations. Hemorrhage is slight and is controlled by packing on one side while the work continues on the other. The spinal muscles are then retracted laterally to expose the entire area to be fused. The

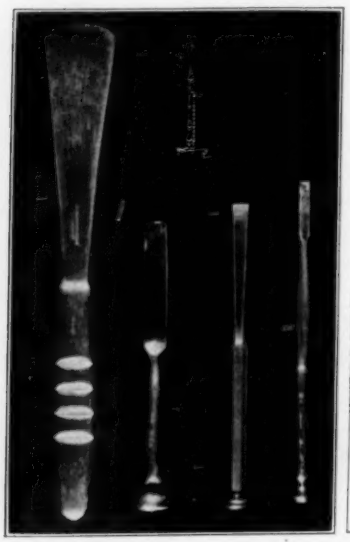

FIG 1

Raspatory, spinal hand gouge, and chisels.

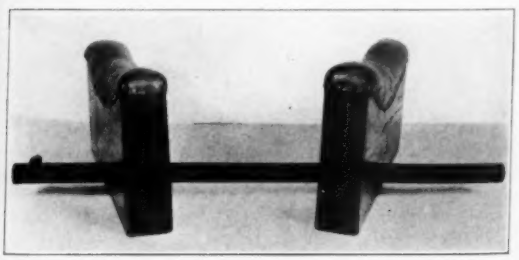

FIG. 2

Shoulder rests.

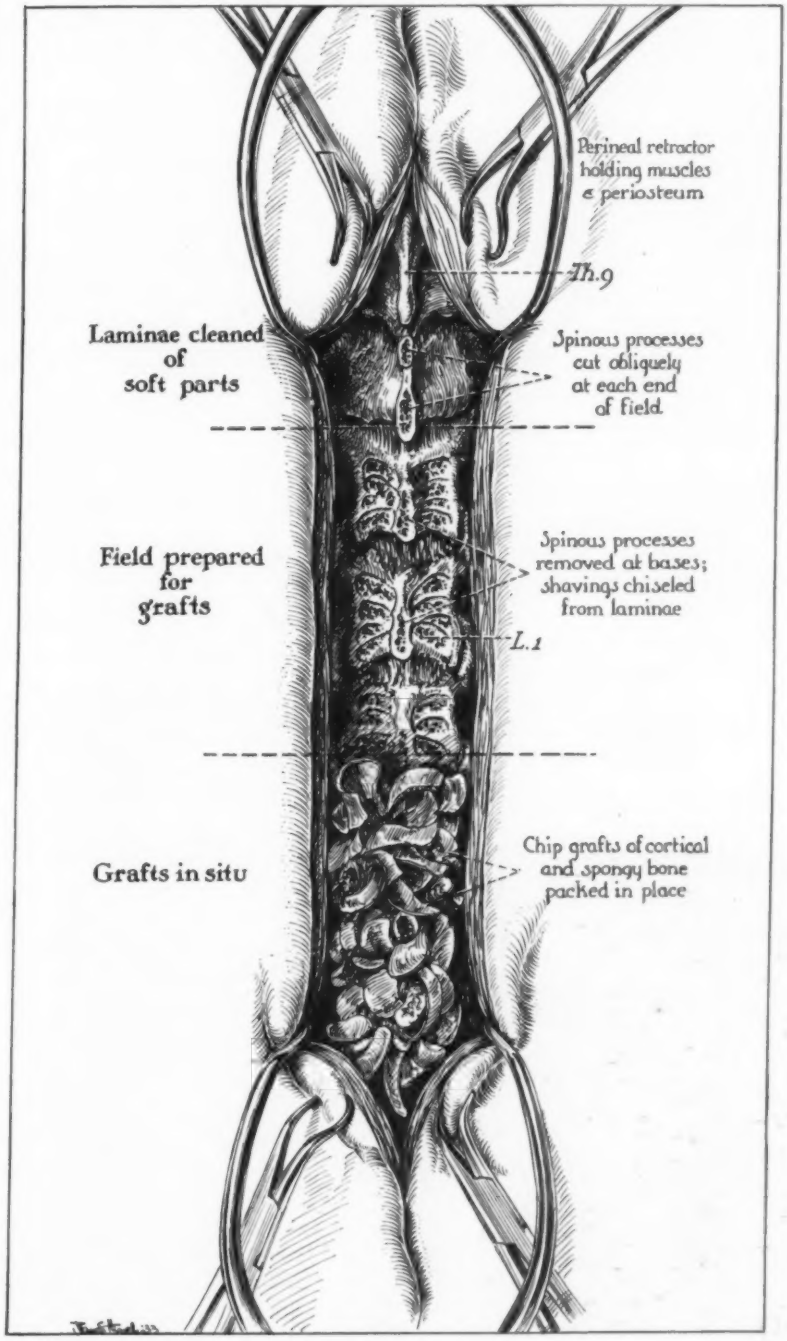
Perineal retractor holding muscles & periosteum
Th.9
Laminae cleaned of soft parts
Spinous processes cut obliquely at each end of field
Field prepared for grafts
Spinous processes removed at bases; shavings chiseled from laminae
L.1
Grafts in situ
Chip grafts of cortical and spongy bone packed in place

FIG. 3
Operative technique.

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FIG. 4
Fusion for spondylolisthesis.

FIG. 5
Fusion for chronic strain from unilateral sacralization.

FIG. 6
Fusion for tuberculosis of the spine.

laminae are carefully cleaned of all soft parts from the bases of the spinous processes out to the articulations. Next, by using a hand chisel (Fig. 1) and utilizing the spines for leverage, small, thin shavings of bone are removed from the laminae until their exposed surfaces are entirely raw. The spinous processes with their intact interspinous ligaments are clipped off at their bases with a bone-cutting forceps. One spinous process at each end of the field is cut obliquely to avoid disfiguring bumps.

FIG. 7

Fusion for tuberculosis of the fifth lumbar with spina bifida occulta.

In the meantime, the subcutaneous surface of the tibia has been exposed by the second team. From it multiple chip grafts are removed with a chisel; none of these chips need be larger than the finger nail. During their collection, the chips are placed in a cup of normal saline, to which a bloody sponge or two from the spinal area can be added to make the bath more nearly physiological. The cup of chips is kept warm in a small pan of warm sterile water. A large handful of these chips is needed, and the spinous processes, which have been removed from the upper field, may be cut up and utilized if time permits.

The chip grafts are quickly added to the spinal bed, distributed evenly over it, and pressed into contact with the raw laminae and each other, using the broad blade of the raspatory. The periosteum, muscles, the remaining supraspinal ligament, and the dorsal fascia are sutured over the grafts with chromic catgut interrupted. The subcutaneous fat is closed with plain catgut continuous, and the skin is closed with dermal. In fat individuals, three or four stay sutures may be necessary. The incision is again iodized and mastisol is painted around the wound (but not into it), in order to seal the dressings to the skin and decrease the danger of wound contamination by perspiration.

The stitches are removed after twelve days, and a close-fitting, plaster-of-Paris jacket is applied on the Goldthwait irons. After ten weeks' recumbency, the patient is fitted with a brace of the Osgood type, having axillary crutches, which is usually worn for about three months.

TUBERCULOUS BURSITIS WITHOUT ADJACENT JOINT INVOLVEMENT FOLLOWING TRAUMA *

BY WILLIAM J. STEWART, M.D., COLUMBIA, MISSOURI

The occurrence of tuberculous disease of a bursa which does not involve the adjacent joint is rather rare. One such case was treated in our Clinic. Investigation of the literature of recent years, including standard orthopaedic textbooks, does not reveal a large number of such cases. Older articles [1] on the condition are found which contain no reference to x-ray findings of the adjacent bone or joint tissue and are consequently of little value. Cone [2] reports a case of subdeltoid tuberculous bursitis

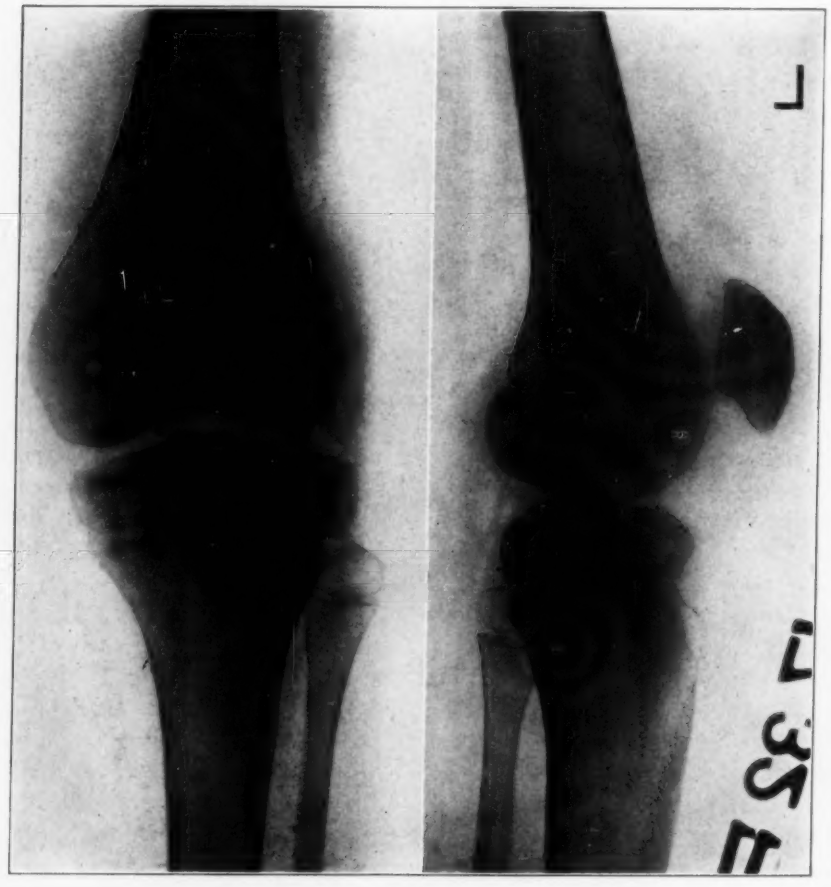

FIG. 1-A

Left knee, showing some elevation of the patella but no bone involvement.

* From the Department of Orthopaedics, Crippled Children's Service, University of Missouri.

without joint involvement, Bérard and Dunet [3] another similar example. Ciaprini [4] records tuberculous disease of the gluteal trochanteric bursa but gives no microscopic pathology. Torraca [5] reports the condition found in the subtricipital bursa at the elbow but mentions no x-ray findings or its possible connection with the elbow joint. A check of the standard orthopaedic texts in English reveals only one mention [6] of the condition.

The following is a case report from this Service:

An eleven-year-old, white male presented himself for examination, complaining of swelling in the left knee. Five months before, he had been hit by a baseball on this knee. There was immediate swelling of the knee with pain, lasting about one week. The first treatment by a physician consisted of massage with an iodin ointment which relieved the pain, but the swelling persisted. Six weeks after the injury, fluid was aspirated. It was bloody appearing and apparently had a few bits of flaky material in it. The patient was told that no organisms were found in the fluid. A plaster cast was applied which was left on for five weeks. After the removal of the cast, the knee was bandaged for two more weeks and then baking and massage treatments were instituted.

Physical examination in this Clinic five months after the injury was not remarkable except for the knee, which showed one-half inch greater circumference at the patella, a

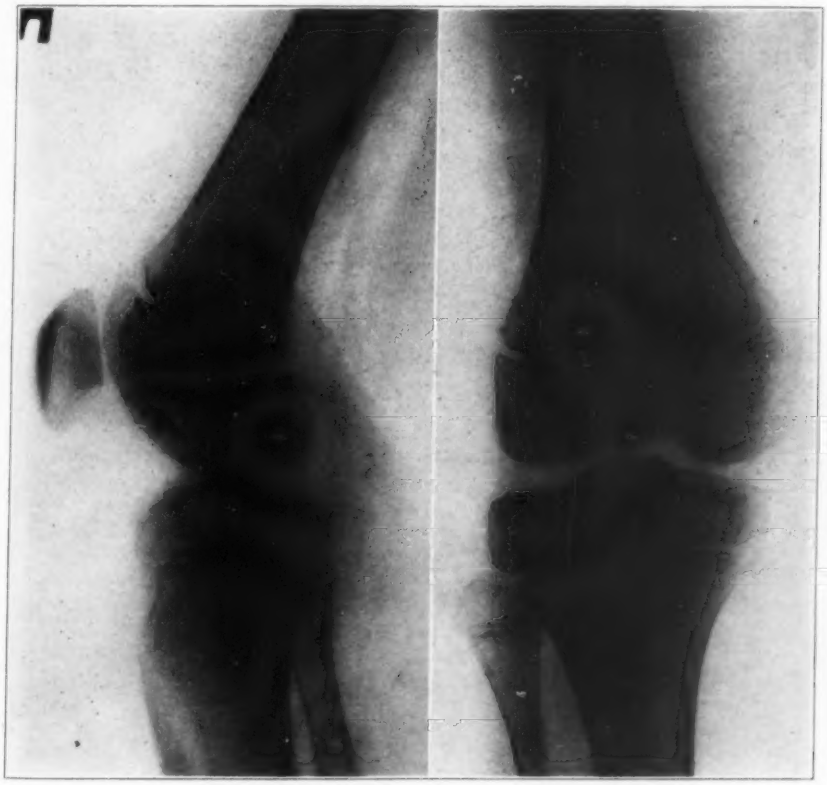

FIG. 1-B

Right knee, normal.

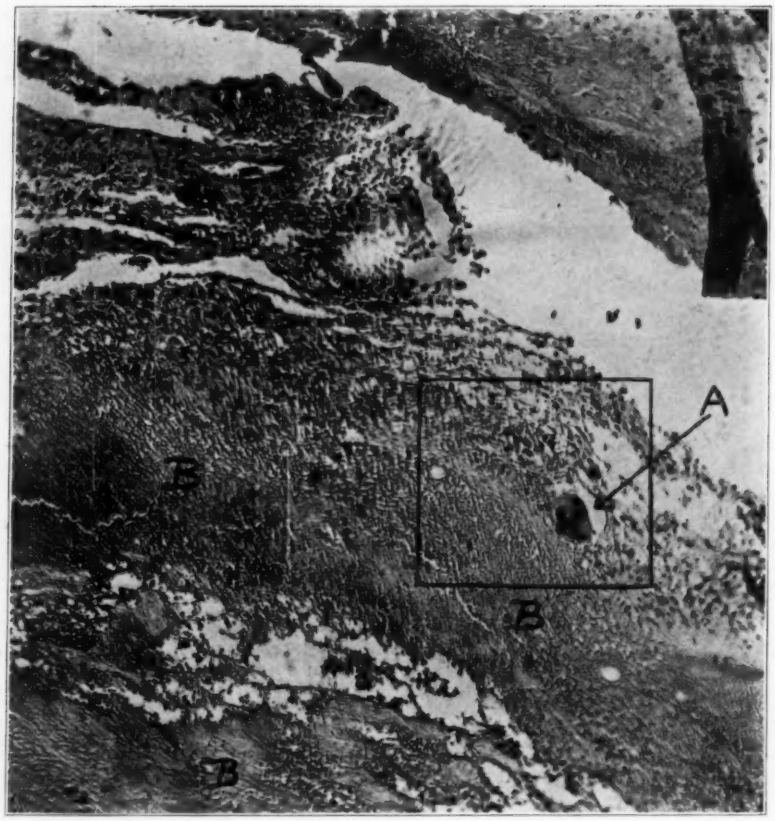

FIG. 2

Low-power photomicrograph, showing giant cell, *A;* with surrounding lymphocytic infiltration, *C;* and caseation necrosis, *B.*
Area in square is shown in Fig. 3.

considerable amount of fluid in the suprapatellar bursa with some thickening about the joint. There were two painful nodular areas where the needle had been inserted previously to aspirate fluid. The patella was freely movable and floated, and the range of motion of the knee joint was complete and painless. There was some increased local heat. For a few weeks before this examination the patient had been having baking of this joint for six hours a day. Roentgenographic examination of both knees was made, as well as a complete blood count, clotting time, and Wassermann, as follows:

Red blood cells	5,328,000
Hemoglobin	100 per cent.
White blood cells	10,240
Polymorphonuclears	60 per cent.
Eosinophils	1 per cent.
Small lymphocytes	39 per cent.
Coagulation time	3 minutes

Wassermann and Kahn tests, negative.

An Ace bandage was applied and the patient discharged for three weeks. It was felt that the excessive treatment by the heat might have been responsible for some of the condition.

Roentgenograms (Figs. 1-A and 1-B) showed no bone involvement.

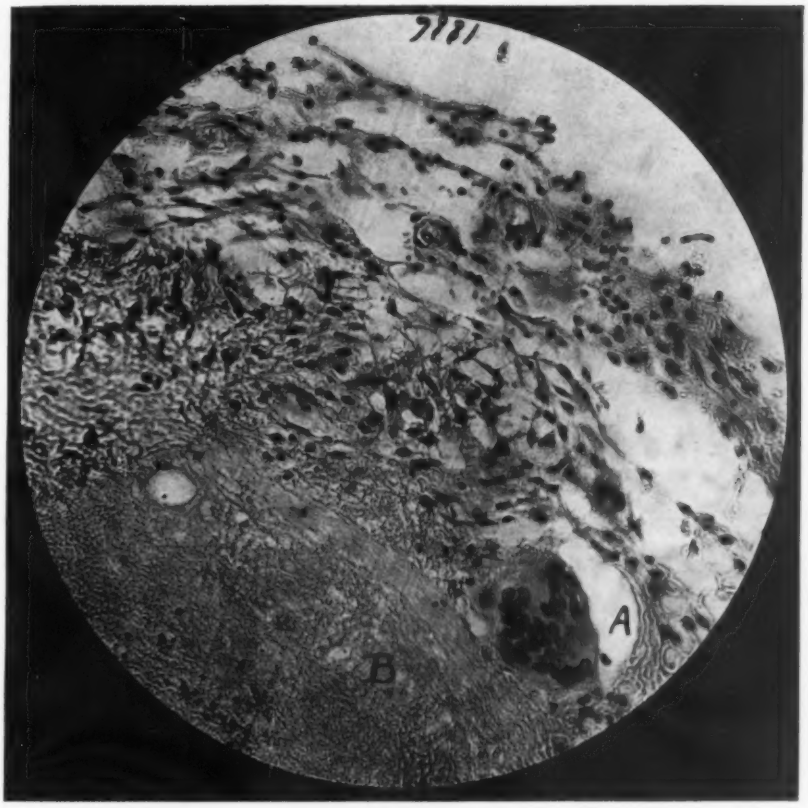

FIG. 3

High-power photomicrograph of square in Fig. 2, showing a few epithelioid cells, lymphocytic infiltration, and adjacent caseous necrosis.

The patient returned in three weeks with a moderate amount of fluid still present and exploration of the bursa was done. A median parapatellar incision exposed the bursa. About fifty to sixty cubic centimeters of serosanguineous fluid with numerous chunks of fibrin were removed. Culture and guinea-pig inoculation from the fluid were done. The bursa was found to be very extensive, particularly toward the medial side. There was no communication with the knee joint and at the time of operation it was felt that the condition was simply a traumatic bursitis, overtreated. Accordingly, after removal of several portions of the sac for microscopic examination, strong tincture of iodin was introduced into the bursa and the wound closed without drainage. A compression bandage was applied to the knee.

Microscopic examination of the tissue removed showed numerous giant cells surrounded by a large number of epithelioid cells, lymphocytic infiltration, and definite tubercle formation (Figs. 2, 3, and 4) with several areas of caseation necrosis. No organisms were cultured from the fluid and the guinea pig that was inoculated was unfortunately accidentally destroyed without examination.

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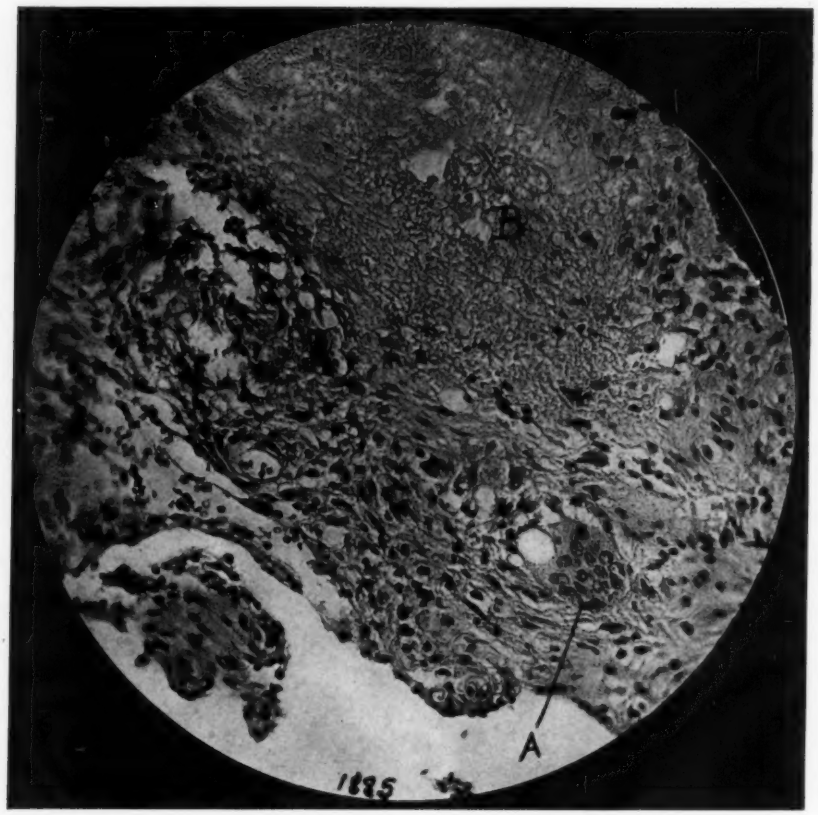

FIG. 4

High-power photomicrograph of another area, showing giant cell, *A*, with surrounding zone of epithelioid cells and lymphocytes, and area of caseation necrosis, *B*.

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SUBCHONDRAL GRANULATION TISSUE IN TUBERCULOSIS OF THE KNEE JOINT*†

BY ERNEST A. BRAV, M.D., ROCHESTER, MINNESOTA

Fellow in Orthopaedic Surgery, The Mayo Foundation

Knowledge of the pathological changes in tuberculosis of the knee joint has been advanced by the researches of numerous investigators during the past century. The disease was first described as a clinical entity by Wiseman in 1676, who applied to it the name of "tumor albus". Its etiology, however, remained obscure. Bell, of Edinburgh, in 1779, expressed the opinion generally accepted at that time, in stating that tumor albus might be due to trauma, scrofula, or rheumatic inflammation.

Bayle and Laennec, early in the nineteenth century, were the first to point the way toward the present conception of the disease. They attempted to convince a skeptical medical world that the gross lesions known as "tubercle" were the result of a constitutional disturbance which could cause localization of the disease at various places in the body, and that these localized processes were pathologically one and the same. Acceptance of this doctrine was gradual. For another fifty years the term "tubercle of bone" was used to refer to any nodular swelling, and most writers still distinguished between this condition and "scrofula".

Rokitansky, in 1844, first demonstrated pathologically the presence of localized tubercles in the synovial membrane and pointed out their similarity to lesions in the lungs. Köster, in 1869, showed that these lesions could exist in so called scrofulous joints with no gross evidence to warrant the diagnosis of tuberculosis.

Following the discovery of the bacillus of tuberculosis by Koch in 1882, the classic description of tuberculosis of joints, both gross and microscopic, was presented by König in 1884, followed by more detailed studies in 1896 and 1906. Basing his observations on a large series of specimens obtained at necropsy, König portrayed accurately the various pathological forms of the disease and expressed pathogenetic theories which have undergone little alteration to the present day. Krause, in 1899, dealt at length with the pathological changes of the disease, and more recently they have been described by Nichols, Ely, Stiles, and Fraser, and several others whose views will be presented briefly.

According to Keith, Toynbee was the first to describe a "subarticular plexus" which formed below the cartilage in cases of inflammation of joints, uniting at times with the "superficial nucleated vascular membrane" in the substance of the cartilage, thus replacing it by fibrovascular

* Thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Orthopaedic Surgery, October, 1932.

† Submitted for publication January 4, 1933.

tissue. In König's early work, he made no mention of this definite layer of granulation tissue, but wrote of subchondral destruction. In his later publication,[12] he described and showed by diagram the "*Knochen Osteitis granulosa*" which corresponds to subchondral granulation tissue. He made no mention of it as being tuberculous, and his sketches do not portray the characteristics of tuberculous tissue. Cheyne, writing in 1911, stated "newly formed tissue spreads in between cartilage and bone", but he made no mention of the composition of this tissue. Fraser acknowledged the presence of subchondral granulations, stating, "The infiltrating zone is a vascular granulation tissue which does not possess an extreme degree of disease; in fact, the cytological evidence of tubercle is at a minimum."

Phemister stated that destruction of cartilage in the region of contact and pressure—that is, the center of the joint—is caused by "undermining subchondral granulations, tuberculous at the periphery, perhaps, but non-tuberculous under the central portions of the cartilage. The latter consists of capillaries, fibroblasts, round cells, and some polys." He stated that the subchondral granulations rarely invade the bone to any extent, but that the marginal granulations may cause some bony destruction. Phemister expressed the opinion that the synovial granulation tissue containing epithelioid cells and giant cells is the response to bacilli of tuberculosis, whereas the subchondral granulations are a foreign-body tissue reaction to the dead cartilage of the articular surface and are not due to invasion by the specific organism. In Kaufmann's "Pathology" the statement appears that "subchondral marrow takes part in the overgrowth without being necessarily tuberculous. It is usually richly vascular, gelatinous, or lymphoid and enters the cartilage like marrow spaces. Giant cells may become chondroclasts."

Allison and Ghormley stated that the "subchondral infiltration by granulation tissue is seen in nearly every case of tuberculosis which has not become so advanced as to destroy completely the structures making up the joint. We have seen an entire articular cartilage undermined before much development of the tuberculosis has taken place." They attributed more importance to this tissue, in so far as cartilaginous destruction is concerned, than to the formation of the superficial pannus. They stated further, "rarely one finds a tubercle along the course of the subchondral invasion. Where such a tubercle exists one often sees a focus developing in the bone."

MICROSCOPIC PATHOLOGICAL CHARACTERISTICS IN GENERAL

Aside from the improvement in detail brought about by more accurate laboratory equipment and the development of photographic apparatus, the present picture of the microscopic changes seen in tuberculosis of the knee joint presents little noteworthy variation from that described by König. It is true, however, that much work on the histogenesis of the tubercle, its why and wherefore, as demonstrated by Krause,

Cunningham, Sabin, and others, has thrown an entirely new light on the subject.

It is fairly well established that tuberculosis of the knee may occur primarily either in bone or synovial membrane. If the bone is first involved, the disease spreads from the epiphysis to the articular cartilage, eroding and perforating it, or it advances to the synovial membrane at its point of reflection from the bone. In either case, the original lesion is the primary tubercle which either becomes encysted and localized or infiltrates the tissue, depending on the virulence of the infection and the amount of individual resistance of the host. In the process of invasion, conglomerate tubercles and diffuse granulation tissue are produced. The bony trabeculae are eroded and the marrow is replaced. Uniform atrophy of the surrounding bone and a tendency to wall off the infection by formation of fibrous tissue occur. If small portions of necrotic bone are not absorbed, minute sequestra or "bone sand" result. If the nutrition of a rather large portion of bone is cut off by a tuberculous embolus or by tuberculous granulations, a large V-shaped sequestrum forms with its base usually on the surface of the joint. If the granulations undergo caseation, gross abscesses may form in the bone or in the synovial membrane.

When the synovial tissues become involved, whether primarily or secondarily to disease in the bone, certain additional changes occur. The original miliary tubercle advances through the synovial substance, although the progress may be slow, as is often the case in tuberculous lesions. In addition, a tuberculous pannus grows across the articular surface from the synovial reflection, eroding the cartilage from above. There is invasion of the bone at the margin of the joint, and this may progress from the line of attachment of synovial membrane to the deeper bony tissue. Finally, at the synovial margin, a thin layer of granulation tissue is formed, which progresses between the cartilage and the bone toward the center of the joint, eroding the two adjacent structures as it advances. Little has been written concerning the nature of this subchondral granulation tissue. It is my purpose in this paper to deal solely with the structure of these subchondral granulations, and to emphasize their relationship to the concurrent gross and microscopic changes taking place in other portions of the tuberculous knee joint.

MATERIAL STUDIED

A study was made of 102 tuberculous knee joints, obtained by resection or after amputation. All specimens included the largest portion of the lower end of the femur and the entire upper end of the tibia and were complete. In more than half of the cases the patella was also intact. In ninety-one of these cases, microscopic sections were made through various portions of the articular surface. When a pannus was present, an effort was made to cut the section through the point of attachment so that marginal pannus, cartilage, subchondral granulation tissue, and bone

would be present in the section. The tissue was decalcified with nitric acid, embedded in celloidin, and sections were cut and stained with methylene blue and eosin.

MICROSCOPIC CHARACTERISTICS OF SUBCHONDRAL GRANULATION TISSUE IN THE MATERIAL STUDIED

In this series of ninety-one microscopic specimens the subchondral granulation tissue was found to be distinctly tuberculous in eleven (12.1 per cent.). In fifty-three cases (58.2 per cent.) definite subchondral granulations were not demonstrable because of complete cartilaginous destruction, or because of the presence of a bony tuberculous focus beneath the cartilage. In the latter cases it was impossible to determine whether the tuberculous tissue beneath the cartilage was the result of the advance of the bone lesion toward the surface of the joint or of the ingrowth of subchondral granulations from the margin of the joint. In twenty-seven cases (29.7 per cent.) the subchondral granulations gave no conclusive evidence of tuberculosis, although in several of them the presence of numerous epithelioid cells, with an occasional foreign-body giant cell, was highly suggestive of such a condition.

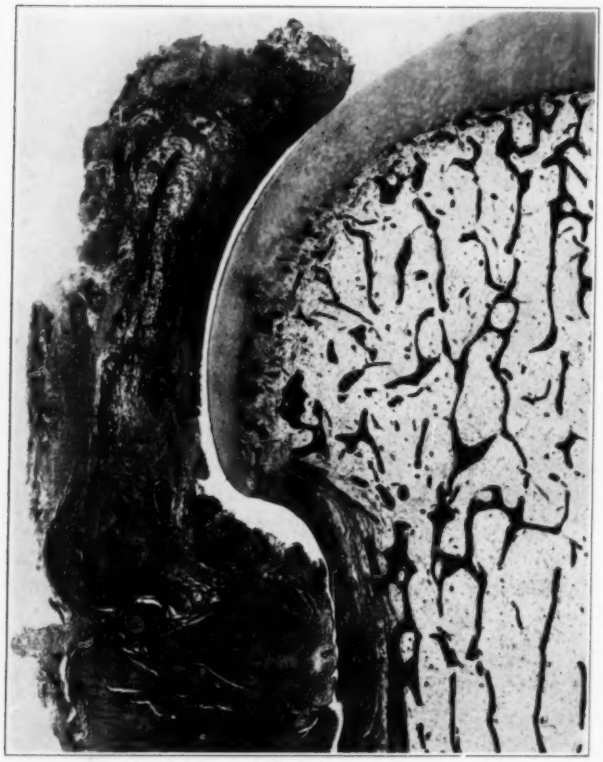

FIG. 1

Section through the margin of the femoral condyle. Symptoms existed for eight months. A tuberculous pannus is growing from the margin toward the center of the joint. Subchondral granulations of non-specific type are approaching the pressure area from the line of synovial reflection. The cartilage has been invaded by the subchondral granulations, but in this case the pannus has produced no erosion of cartilage (× 7).

Although theoretically the earliest lesions in tuberculosis of the knee joint may be limited either to the bone or to the synovial membrane, in every one of the specimens studied there was evidence of the disease in

both of these structures. In several specimens derived from patients who had had symptoms of only two or three months' duration this finding was constant. In them the bony structure was eroded at the margins by tuberculous tissue arising at the point of synovial attachment, and a layer of granulation tissue was seen to be progressing beneath the cartilage toward the center of the joint (Fig. 1). In one section a primary bony focus had spread to the margins of the joint, followed by formation of subchondral granulations as in the primary synovial type.

This observation is of practical significance, because it demonstrates the futility of conservative surgical procedures in tuberculosis of the knee joint. By the time the symptoms are sufficiently evident to cause the patient to seek treatment, a synovial lesion already will have invaded the bony structure. At operation the disease may appear to be distinctly limited to the synovial membrane, in which case partial or total synovectomy may seem to be indicated. In practically every case, however, there is hidden below the apparently intact articular surfaces beginning marginal tuberculous erosion and subchondral infiltration, which make entirely useless any surgical procedure short of resection of the surfaces of the joint.

In no instance was tuberculous tissue, the result of a primary bony focus, and present beneath the articular cartilage, called "tuberculous subchondral granulation tissue". Only definite uninterrupted tuberculous tissue arising from a marginal lesion and advancing beneath the cartilage to the center of the joint with no contiguous bony lesion was placed in this category.

In twenty-seven of the cases, ordinary granulation tissue was found to exist beneath the cartilage. This consisted of a layer of varying thickness, comprising fibroblasts, round cells, young capillaries, and in some instances foreign-body giant cells. In each case definite tuberculosis was present in the synovial membrane at its point of attachment to the bone, but no characteristic tuberculous lesions were found in the subchondral tissue. In some cases, however, tuberculous granulations had begun to erode the marginal bone adjacent to the diseased synovial membrane.

Above and below the layer of subchondral granulation tissue there existed evidence of destruction of cartilage and of bone, respectively. At certain points the granulations were seen to enter the substance of the cartilage and on the other side to extend somewhat more deeply into the bony structure. The basal cartilage cells appeared swollen and degenerated, and in some cases there was beginning fibrillation. Giant cells were often present in large numbers at the base of the cartilage, evidently taking active part in the process of destruction. In several specimens the subchondral penetration was seen to unite, in the body of the cartilage, with the invading tuberculous pannus from above. In these sections the twofold process of cartilaginous thinning and destruc-

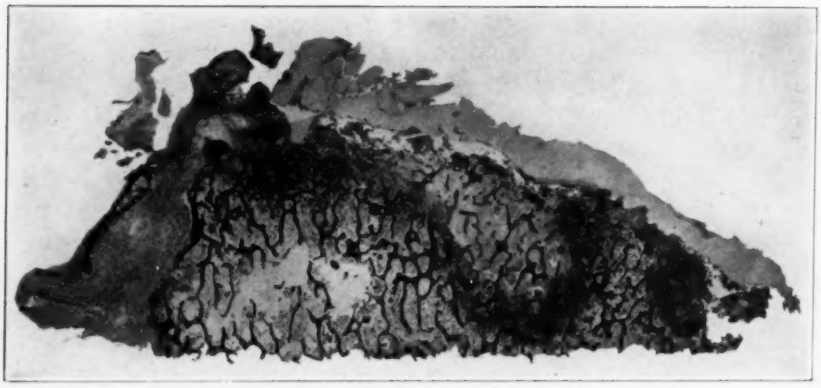

FIG. 2

Section through tibial tuberosity, showing tuberculous subchondral granulations advancing in unbroken line from a synovial focus to the center of the joint. The cartilage is dead and has been partially separated from the bone. At the pressure area the subchondral granulation tissue encircles a small sequestrum and then continues onward beneath the cartilage (× 4).

tion was readily demonstrated. The bony tissue was similarly eroded in many instances, the trabeculae appearing atrophic, fragmented, and surrounded by numerous foreign-body giant cells.

Whereas in most instances the width of the layer of subchondral granulations was practically constant from the margin of the joint to the center, in some of them a difference was noted. In nine of the twenty-seven cases mentioned (33.3 per cent.), the granulations were more luxuriant at the margin, thinning out as they advanced to the area of pressure. In three cases (11.1 per cent.), there was distinctly more evidence of subchondral granulation tissue at the central portions than at the periphery, whereas in fifteen cases (55.6 per cent.), the layer was uniform in width.

If, as Phemister has suggested, subchondral granulation tissue is a foreign-body tissue reaction to destroyed cartilage, it is reasonable to believe that this tissue would be found only in the regions where there is evidence of such a process. Of this group of twenty-seven specimens, the sections of which revealed non specific subchondral granulations, in six cartilaginous destruction was greater at the pressure areas; fourteen specimens presented greater marginal destruction; and in seven the destruction was uniform in the pressure areas and at the margin. Of the six specimens in which central destruction was greater, in five there were, microscopically, equal amounts of subchondral granulations on both regions of pressure and at the margins, whereas in one there were more granulations at the center of the joint. In the fourteen specimens with greater marginal destruction there were only marginal or more extensive marginal granulations in eight cases, more abundant central granulations in two cases, and a uniform amount of granulation in four cases. Of the seven specimens with uniform cartilaginous destruction, there were

evenly distributed subchondral granulations in six, and in one the tissue was found to occur more extensively at the periphery.

Since there seems to be no consistent relationship between the site of cartilaginous destruction and the region of maximum growth of subchondral granulation tissue, it does not appear probable that the latter is merely a reaction to contiguous foreign material. In specimens with only marginal cartilaginous disease, there were in some cases subchondral granulations beneath the intact central portion. In those with marked central destruction and practically intact marginal cartilage, the subchondral granulations were always seen beneath both portions. In no case were granulations limited to the central region of destruction.

FIG. 3

Section through the center of the joint showing tuberculous nodules in the subchondral granulation tissue (× 65).

Several of the sections which have been classed as non-specific subchondral granulation tissue had characteristics resembling tuberculosis. In them were seen collections of epithelioid cells and lymphocytes which lacked only the typical configuration for the diagnosis. Since these collections were also at times seen in sections which elsewhere displayed tubercles, it is possible that they represent an early type of lesion or a reaction to a weakened tuberculous infection. Foreign-body giant cells were noted in fourteen (51.8 per cent.) of the specimens of granulation tissue classified as non-tuberculous. These alone were not considered suggestive of tuberculosis.

When a diagnosis was made of tuberculosis in the subchondral granulation tissue, there were always present the characteristic structure and configuration, and in all cases the tissue was seen to be extending in unbroken line from a synovial focus to the center of the joint (Fig. 2). Collections of epithelioid cells and lymphocytes were considered essential to the diagnosis, with or without the presence of giant cells. In all

FIG. 4

Section through the pressure area in a specimen in which greatest cartilaginous destruction is at this point. The cartilage has been eroded by the opposed pressure. The cartilage cells are enlarged and degenerated and there is beginning fibrillation. Subchondral granulations of non-specific type are present below the central cartilage, causing thinning and loss of nutrition (× 65).

sections there was a nodular form of tuberculosis (Fig. 3). In no case was caseation present in the subchondral tissue, although in the same sections it was sometimes noted in the tuberculous pannus.

Just as in the case of the non-tuberculous tissue, the regions where the subchondral granulations were most luxuriant did not correspond to the situation of greatest cartilaginous destruction. In seven cases sequestra were present in the sections. These were never noted where the subchondral tissue was not definitely tuberculous. The granulations in these cases were seen to dip down below the cartilage, to surround the region of sequestration and then to proceed beneath the cartilage again (Fig. 2). In only one of the seven cases was there evidence of a bony tuberculous focus. In two cases the sequestra were entirely denuded of cartilage. In the remaining five, dead cartilage covered the necrotic bone, and in none of these were subchondral granulations present beneath the cartilage of the sequestrum although they did exist beneath adjacent cartilage. Sequestra were noted at the pressure area in six cases and at the margin in one case.

The subchondral granulation tissue, whether or not definitely tuberculous, seemed to bear no relationship to the marginal pannus formation. In some specimens in which the process was not advanced there was apparently granulation tissue extending below the cartilage to the same extent as the pannus existed above it. However, in most cases the granulations were present below the center of the cartilage over which the pannus did not exist, or they were seen only at the very margins with a well-

developed pannus on the surface of the cartilage. In the majority of the sections one could demonstrate a more extensive encroachment of the center of the joint by subchondral granulations than by pannus.

COMMENT

Subchondral granulation tissue evidently takes an active part in the progress of tuberculosis of the knee joint. Whether or not this tissue can be shown to contain definite tubercles, it is responsible for many of the pathological changes in cartilage and in bone. Marginal erosion of the bone in cases which appear grossly to have only involvement of the synovial membrane is one of its most important accompaniments. Destruction of cortical bone with little if any diminution of the joint space, one of the earliest roentgenographic signs, is the result of the invasion of subchondral granulation tissue.

Destruction of cartilage at the center of the joint is due largely to the presence of subchondral granulations. Cartilage, in tuberculosis of the knee joint, is destroyed by (1) the marginal pannus, (2) tuberculous toxins, (3) pressure of opposed articular surfaces, and (4) subchondral granulation tissue. König was the first to observe that usually the cartilage is preserved at the areas of contact and pressure and destroyed at the periphery. Phemister pointed out that the superficial pannus is usually rubbed off at the center of the joint, due to opposing pressure. He stated that in tuberculous joints, unlike pyogenic joints, the central cartilage is not often eroded by the effects of pressure, because its resistance is not greatly impaired by the action of the tuberculous toxins which are lacking in proteolytic ferments.

When subchondral granulation tissue is present beneath the center of the joint, however, the picture is somewhat altered. The central cartilage is attacked from below, its nutrition is impaired, and it becomes less resistant to the effects of opposing pressure. Thus, of the thirty-eight specimens showing definite subchondral granulations, ten gave evidence of greater destruction at the center of the joint, and every one of these presented microscopically a central growth of subchondral granulation tissue (Fig. 4), four being definitely tuberculous. Of the sixteen specimens with greater marginal cartilaginous destruction, only seven (43.8 per cent.) had subchondral granulations beneath the central cartilage and none of these was tuberculous. Therefore, it appears that the tuberculous infection incites a response of granulation tissue beneath the cartilage, and that this is one of the most important factors in determining the site of greatest cartilaginous destruction. Why in some cases there should be more central advance of this tissue, with resultant destruction in pressure areas, is as yet unexplained. Weight-bearing seems to be of only minor importance. About half of the specimens with greater central destruction were derived from patients who had given histories of having walked on the leg most of the time prior to operation. The histories of

the others indicated that there had been some treatment at one time designed to place the joint at rest.

Duration of disease likewise appears to bear little relationship to the growth of subchondral granulation tissue. The nine specimens with marginal destruction and no central subchondral granulations were from patients who had had evidence of disease over a period averaging four and four-tenths years, whereas the seven specimens which exhibited this tissue at the center of the joint were from patients who had had evidence of disease for a period averaging only three and seven-tenths years.

From a practical point of view, the question has been raised as to whether traction is indicated in the non-operative treatment of tuberculosis of the knee joint. It has been shown that the superficial erosion of cartilage at the center of the joint, by formation of pannus, is prevented or at least delayed until the late stage of the disease by the pressure of the opposed surfaces. Judging from this observation alone, traction would appear to be contra-indicated. However, if there is a central growth of subchondral granulation tissue in the joints and traction has not been applied, there will result in most cases erosion of the central cartilage from the effect of the opposing pressure. Obviously there can be no uncompromising rule established for suitable treatment in all cases.

Severity of the tuberculous infection and the amount of individual resistance may be factors in determination of the amount of subchondral granulation tissue formed and consequently in determination of the site of greatest cartilaginous destruction. In this series there was no clinical evidence of such factors having been causes of the changes mentioned. It is possible, as Phemister has suggested, that in severe tuberculous infections the toxins produced within the joint are capable of reducing the resistance of the central cartilage to the opposing pressure area, as in pyogenic joints.

Subchondral granulation tissue seems to be of importance in the formation of bony sequestra at the articular surfaces. König believed that sequestra were due to the blocking of an epiphyseal vessel by tuberculous tissue, thereby causing necrosis of bone in a V-shaped area with the base on the articular surface. Phemister wrote also of "secondary sequestra" which, according to the belief he expressed, are formed by invasion of the central bone by tuberculous tissue penetrating the cartilage from the surface of the joint. In this series of thirty-eight specimens, the presence of sequestra was demonstrated in seven. In one case there was evidence of a bony focus which might have been the cause of the region of necrosis. None gave evidence of penetration of the central cartilage as an etiological factor of secondary infection. In six cases the subchondral granulation tissue was seen completely to surround the sequestra except on the cartilaginous surface. In these, the granulations appeared to play a definite part in the formation of sequestra, some unexplained change in the reaction of these portions of the bone causing the granulations to

proceed around rather than through them. The observation that in each of the six cases the sequestrum occurred at the pressure area may be of more than incidental importance in the mechanism of their formation.

SUMMARY

Microscopic sections through the articular surfaces of ninety-one tuberculous knee joints were studied. The complete joint was available in each instance. In forty-one and seven-tenths per cent. of the cases subchondral granulation tissue, arising from the margins of the joint, was seen to exist between the cartilage and the bone. Of the specimens in which subchondral granulations were present, there was definite evidence of tuberculosis beneath the margin and center of the cartilage in twenty-nine per cent. Several others were extremely suggestive of tuberculosis but in them definite diagnosis could not be made. Subchondral granulation is probably a tissue reaction to an infectious process, rather than to foreign material in the form of degenerated cartilage. Whether or not it presents the actual cellular characteristics of tuberculosis, it must be considered potentially tuberculous. Subchondral granulation tissue in tuberculosis of the knee joint plays an active part in erosion of bone, demarcation of sequestra, and destruction of cartilage.

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FRACTURES OF TIBIA AND FIBULA

Kirschner Wire Method Using a New Frame and New Support for Wires *

BY C. F. EIKENBARY, M.D., F.A.C.S., AND JOHN F. LECOCQ, M.D.,
SEATTLE, WASHINGTON

A perusal of the records of the Industrial Insurance Department of almost any state must leave one with the thought that the results of treatment of fractures of both bones of the leg are far from satisfactory. The examination of the roentgenograms in most general hospitals would lead one to the same conclusion. Quite a percentage of the cases show a moderate or even a marked malalignment, resulting in improper weight-bearing. A slight malalignment is quite apt to produce a marked disability. In no other fracture is the question of alignment of greater importance. Many of the cases that are properly aligned will show too little contact, or even an overriding. While a partial contact may eventually give a good functional result, it is too often true that a fairly high degree of permanent partial disability will result; and always the period of convalescence is too prolonged.

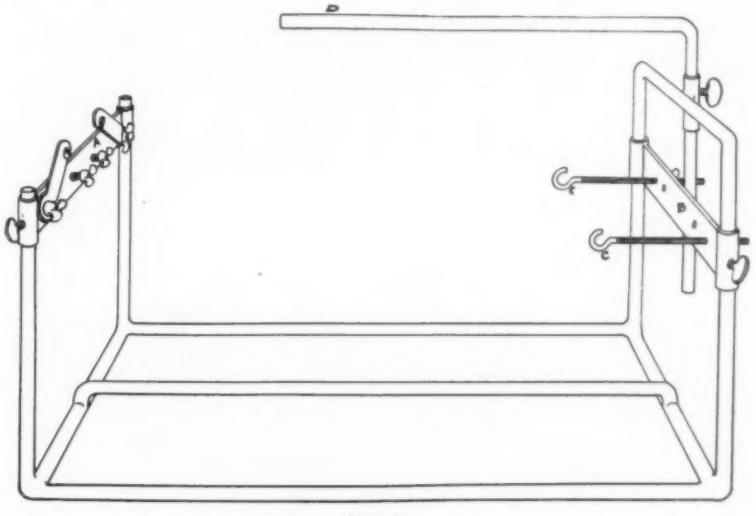

FIG. 1

Traction frame. The cross bars *A* and *B* are adjustable up and down. The horse-shoe metal supports, to which the transfixing piano wires are secured, are firmly anchored to the bar at *A*. *C* and *C* are the traction hooks, operated by two thumb screws (Fig. 7). By tightening or loosening one or the other of the thumb screws, a lateral shift of the lower fragment may be obtained. *D* is an overhead piece, detachable, for supporting the leg (Figs. 7 and 8).

* Presented at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 11, 1933.

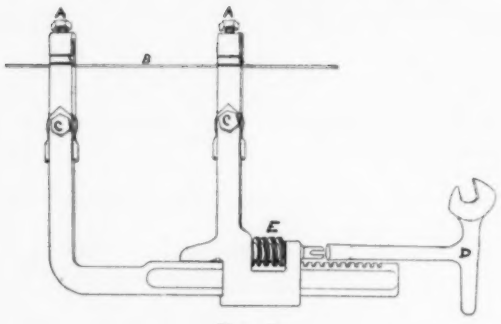

FIG. 2

New type of cross support for Kirschner wires. *A* and *A* tightening nuts for securely clamping wire *B*. *C* and *C* nuts for clamping the terminal bars into the main body of the frame. By means of the adjustment screw *E*, almost any width may be secured. *D* is the tightening wrench.

In reviewing the roentgenograms of the Industrial Insurance Department, or of most any general hospital, we are rather forcibly impressed with the thought that the failure to ultimately achieve perfect functional results is not because of failure to secure good reduction. The roentgenograms generally show that very excellent reduction was obtained, but later roentgenograms all too frequently show that the good reduction has changed to a displacement, either moderate or severe. The question immediately arises as to why, under treatment, this displacement should occur. And can it be prevented?

Probably the most common method of treatment in this type of fracture, certainly the most common method in the hands of the general

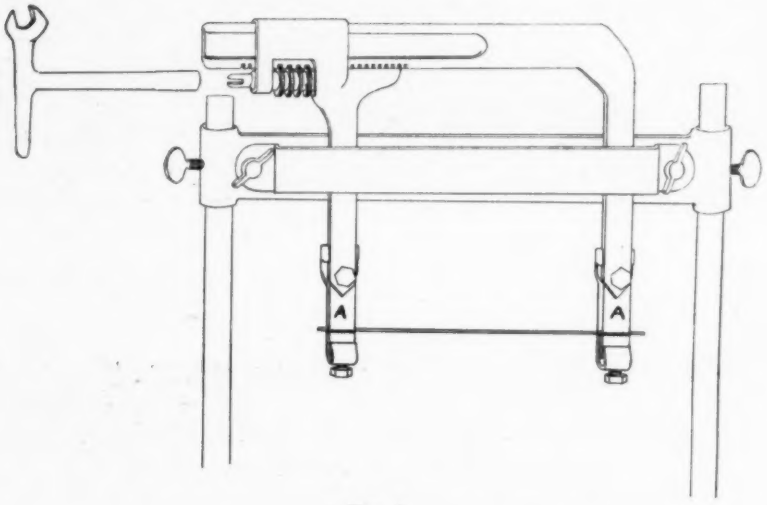

FIG. 3

End view of frame, showing the upper U-shaped support in position and firmly clamped. After reduction, only the terminal portions *A* and *A* remain in the plaster.

practitioner, is the application of a plaster support. Mechanically, a plaster support is anything but ideal. The bone is a very unyielding substance, surrounded by a very soft, yielding, contracting muscular cushion. Regardless of how snugly the plaster is applied, and regardless of the position of the foot or knee, the soft, yielding muscular cushion is still

present. This being true, there is every reason for the slightest contraction of the muscles to produce displacement. If all fractures were deeply serrated, and we could always so reduce them that the serrations were perfectly fitted into each other, then we might be reasonably certain that most any type of support would suffice. But such is far from the case. Very few fractures are completely transverse, and even if they are, we seldom reduce them so perfectly that the bony serrations can maintain the reduction.

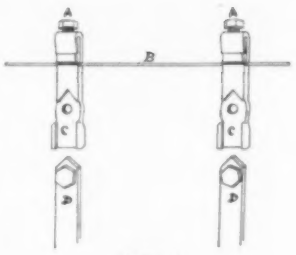

FIG. 4

Showing the terminal bars *C* and *C* disconnected from the major portion *D* and *D*. Only the terminal bars are left in the plaster.

Open operation with plating or some other form of internal fixation will, of course, maintain the position. The advantages and disadvantages of this method of treatment have been

FIG. 5

Sites for injecting the two per cent. novocain. *A*, site for the upper wire. *B*, the lower wire. *C*, the fracture. *D*, the os calcis. We no longer use the os calcis for traction purposes.

FIG. 6

The two plasters have now been applied, and the metal horse-shoe supports that anchor the wires have been firmly imbedded in the plaster.

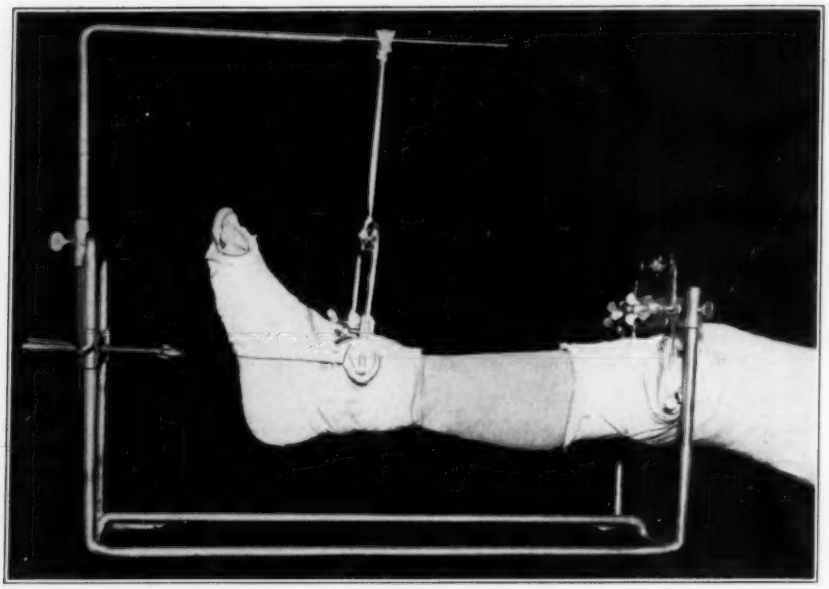

FIG. 7

The leg is now placed in the traction frame, and reduction accomplished by means of traction on the wires that are fastened to the thumb screws.

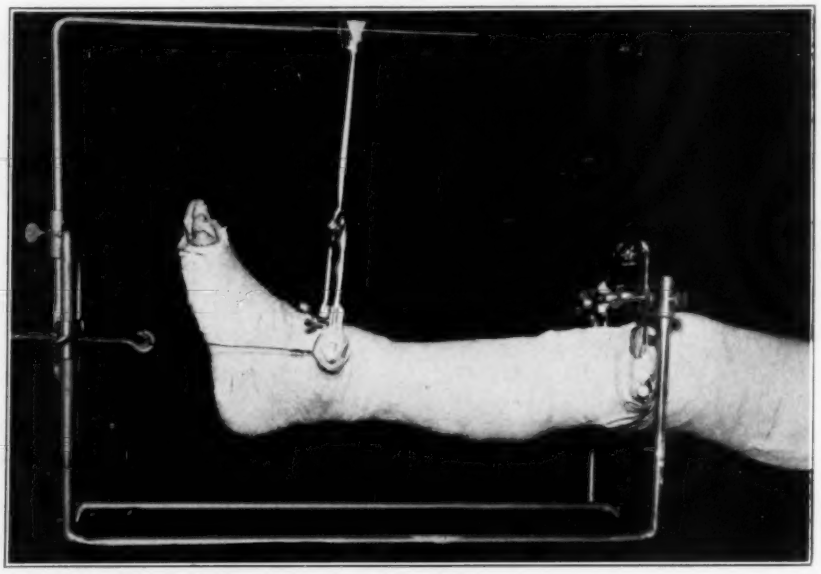

FIG. 8

The fracture is now reduced and the connecting plaster applied.
The fractured tibia, the piano wires, the metal supports, and the plaster are now one, and move as one. Regardless of position displacement cannot occur.

discussed many times. There is nothing new to add. However, the innumerable cases of draining sinuses and of non-union should be sufficient to convince us that open operation is not a treatment to be

FIG. 9

The transverse portions of the metal supports have been removed. The plaster securely anchors the lateral supports for the piano wires. The patient now becomes ambulatory, using crutches.

routinely used. In the hands of most men it is a dangerous procedure. In practically all cases it is quite unnecessary.

To maintain reduction, it is necessary in most cases to use traction, either fixed or otherwise. Traction in bed, preferably by the skeletal method, will certainly suffice to insure proper length and alignment. Its only disadvantage is the necessity of keeping the patient in bed. Considering the cost of hospitalization, the necessity of long confinement in bed becomes quite a serious problem.

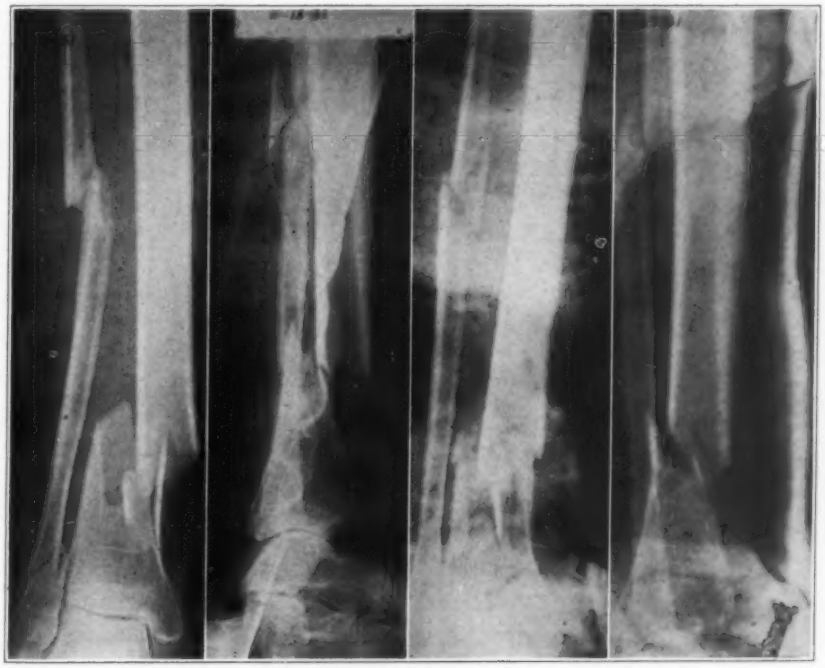

FIG. 10
Case 1.

FIG. 11
Case 2.

The ideal method is one whereby the fracture may be reduced, the traction maintained, the fracture so fixed that displacement cannot occur, and the patient allowed to be up and about. The use of Kirschner piano wires ideally answers all the above requirements. For several years we have used the following method and have had absolutely no reason to question its efficiency:

1. Local anaesthesia in the site of fracture as well as in both the upper and lower ends of the tibia (Fig. 5).

2. Transfixing both the upper and the lower ends of the tibia by the piano wires. The small wires are pointed as for drilling. No incision is necessary, the wires being drilled through the bone, the opening being just about the size of a hypodermic needle (Fig. 5).

3. Securing the wires to the metal cross support and then tightening the wires until they are quite rigid (Fig. 2). When tightened, a pull of fifty pounds will not produce an appreciable bend.

4. Application of a plaster support from the mid-thigh to a point just above the site of fracture, and another plaster support including the foot and going up to a point just below the site of fracture. These two plasters are firmly attached to the two U-shaped cross supports (Fig. 6).

The plaster having firmly set, the leg is placed in the traction frame (Fig. 1). The upper U-shaped cross support, holding the piano wire, is firmly clamped into the proximal portion of the frame (Fig. 7). Traction wires are now carried from the lower U-shaped support to the turn screws (Fig. 7), after which any necessary traction may be applied. By tightening and loosening either wire, a lateral shift can be obtained. The position of the fracture is now checked by x-ray. If satisfactory, the distal

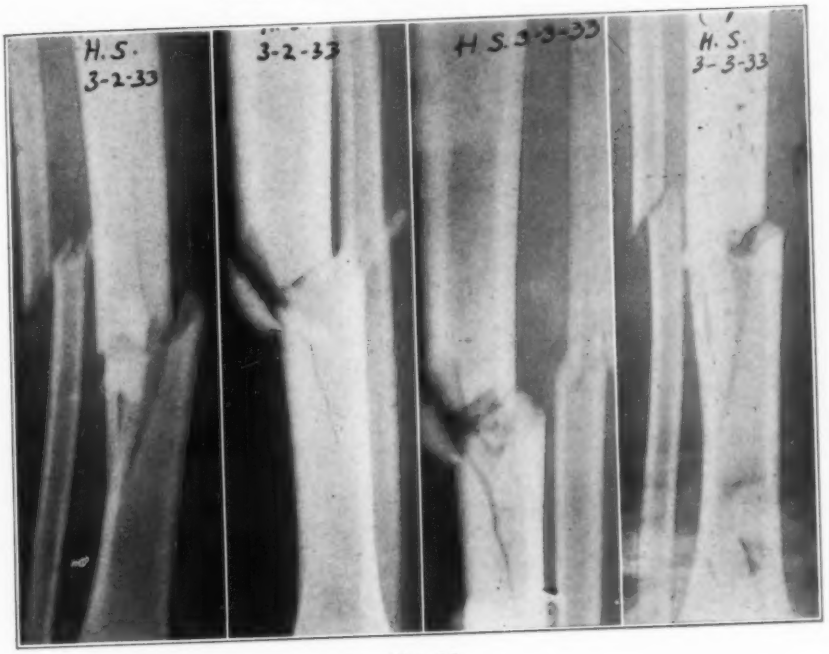

FIG. 12
Case 3.

FIG. 13
Case 4.

FIG. 14
Case 5.

and proximal portions of the plaster are connected by another plaster. When this has been accomplished, the two piano wires, the U-shaped supports, the plaster, and the distal and proximal portions of the tibia are all one and move as one. Regardless of position, the fracture cannot be displaced. The upper portions of the U-shaped supports are now removed, leaving the terminal portion of the U support to maintain the tension on the piano wires (Fig. 9). The patient may be allowed up in a couple of days, and the surgeon need have no worry as to displacement.

The site of insertion of the wires is dressed at the time of the operation, but not again until all dressings are removed. If the fracture is compound, a window may be cut in the plaster without danger of displacement.

The new U-shaped supports greatly facilitate the treatment. They are almost instantly adjustable for any width. Two supports are all that are necessary, since all but the terminal portions of the U are removed as soon as the plaster is firmly set. The frame described herein (Fig. 1) is not absolutely necessary, but is certainly a great convenience.

The following points are claimed for this treatment:

1. A minimum of asepsis is required.
2. Mechanically, the treatment is easy of execution.
3. Reduction and alignment are easily obtained.
4. Having obtained reduction, the surgeon is assured that no displacement can occur.
5. The patient can become ambulatory almost immediately.

OPERATIVE TREATMENT OF SACRO-ILIAC DISEASE

Analysis of Cases and End Results

BY CARL T. HARRIS, M.D., ROCHESTER, NEW YORK

Sacro-iliac disease, including sacro-iliac strains as well as destructive lesions, has become a relatively common diagnosis during the past ten years. This has been caused by a better understanding of the methods of diagnosis, particularly in differentiating between sacro-iliac and lumbo-sacral conditions. As a result of the work of Smith-Petersen, published in 1921, the operative treatment of sacro-iliac conditions has assumed a more prominent place among orthopaedic procedures. Other methods have been devised and advocated by Verrall, Campbell, Chandler, Albee, Gaenslen, and others. Considering the frequency of the diagnosis of sacro-iliac disease and its operative treatment, the reported end results seem few in number.

In 1926 Smith-Petersen reported thirteen cases of tuberculosis of the sacro-iliac joint treated by arthrodesis, with complete recovery in forty-six per cent., partial recovery in twenty-three per cent., and deaths in thirty-one per cent. The deaths were not immediate results of operation. Another series, comprising twenty-six cases and not including tuberculosis, was published by the same author in 1926. Complete recovery was secured in eighty-four and six-tenths per cent., partial recovery in seven and seven-tenths per cent., and failure in seven and seven-tenths per cent. A total of twenty-five out of the twenty-six returned to some form of occupation.

Gaenslen reported in 1927 a series of nine cases operated upon by his method, in which seven returned to work. Campbell in 1927 reported seven cases, in which he secured satisfactory results in five. The other two were too recent to warrant giving an end result. In 1929 Chandler reported five cases of trisacral fusion. Two secured complete relief, and three were too recent for a final report. Phelps and Lindsay in 1929 reported three cases operated upon by a modification of the method of Verrall, in which all had returned to work and were free from symptoms at the end of one year.

In this paper the writer wishes to report a series of sixty-seven consecutive cases of sacro-iliac disease, operated upon between the years 1923 and 1930, inclusive. For purposes of comparison and brevity of detail many of the tables are arranged in a manner similar to those in Smith-Petersen's report of 1926. All cases have been operated upon by the Smith-Petersen method with slight variations which have not changed the operative result.

Before going into the details of this report, it has seemed of interest to determine the frequency of operation in sacro-iliac disease. During this period in our private orthopaedic practice the diagnosis of sacro-iliac

disease was made in 296 cases, representing sixty-seven and one-half per cent. of the total number of patients examined because of low back pain. This percentage is high because of the fact that many of the patients were referred cases, in whom causes other than orthopaedic had been ruled out. In general surgical and internist practice the percentage would be much lower. No attempt was made to enumerate the large number of ward and clinic patients in this tabulation.

TABLE I

FREQUENCY OF OPERATION

	Male	*Female*	*Total*	*Percentage*
Operation performed	22	28	50	16.9
Operation advised but not performed	29	16	45	15.2
Operation not advised	89	112	201	67.9
Total	140	156	296	100.0

Operation was advised in a little less than one-third of the cases seen, and performed in only about one-half of those in which it was advised.

In addition to the fifty private patients mentioned in Table I, this series includes seventeen ward patients operated upon during the same period of time.

TABLE II

SOCIAL STATUS OF PATIENTS

Class	*Male*	*Female*
Private	9	28
Compensation	13	0
Ward	12	5
Total	34	33

In the above tabulation private and compensation patients have been separated, while in Table I they were grouped as private cases.

The youngest patient was thirteen years of age, with the diagnosis of tuberculosis of the sacro-iliac joint. The oldest patient was seventy-four years of age, with a chronic strain superimposed upon a degenerative arthritis, totally incapacitating her. The average was thirty-four and nine-tenths years for the men and thirty-two and three-tenths years for the women. Sacro-iliac disease has occurred in this series almost uniformly during the most productive years of life.

Histories obtained at the original examinations gave the following causes for the sacro-iliac condition.

TABLE III

PRECIPITATING CAUSE OF DISEASE

	Number	*Percentage*
Fall	13	19.40
Lifting	18	26.87
Automobile accident	3	4.48
Infectious process	3	4.48
Pregnancy	3	4.48
Undetermined	27	40.29
Total	67	100.00

The undetermined causes occurred largely in those patients who had had symptoms for a period of years. The duration of symptoms before operation varied from one day to eleven years. The average duration was eighteen and three-tenths months.

Pain was the one common complaint in all cases. The localization varied somewhat.

TABLE IV

LOCALIZATION OF PAIN

	Number	*Percentage*
Sacro-iliac region (unilateral)	53	79.1
Sacro-iliac region (bilateral)	12	17.9
Lumbosacral region	1	1.5
No back pain	1	1.5
Thigh (posterior)	55	82.0
Lower leg	20	29.8

In ten of the twelve cases having bilateral sacro-iliac pain, bilateral sacro-iliac fusions were performed.

The two principal findings were localization of pain to the sacro-iliac region, and extension of pain down the posterior surface of the thigh, reaching the lower leg in only thirty per cent. of the cases. The severity of the pain varied from a dull ache in the chronic cases to extreme pain, requiring large doses of morphin, in the acute cases. The greatest pain noted was in a patient having a definite infectious process.

Physical examination revealed the following findings.

TABLE V

LOCALIZATION OF TENDERNESS

	Number	*Percentage*
Lumbosacral region	12	17.9
Sacro-iliac region (unilateral)	51	76.1
Sacro-iliac region (bilateral)	12	17.9
Anterior abdominal	15	22.3
Pain on iliac crest pressure	12	17.9
No tenderness	3	4.5

The more inconstant findings,—such as muscle atrophy, fibrillary twitching, slight sensory disturbance, etc.—are not enumerated, although they are important as diagnostic aids. In the eighteen per cent. of cases showing some tenderness over the lumbosacral region, the maximum tenderness was over the sacro-iliac region and at the sciatic notch. The tenderness on pressure over the anterior abdominal wall (John Baer's sacro-iliac point) is noteworthy. These cases show only seventeen and nine-tenths per cent. having pain on pressure over the iliac crests, in comparison with fifty-two per cent. in Smith-Petersen's group. Pain on iliac crest compression is a valuable diagnostic sign; its absence, however, does not exclude sacro-iliac disease.

Motions of the back were limited in all cases. Varying degrees of spasm of the erector spinae groups of muscles were found in the majority of cases. Eighteen (26.8 per cent.) of these showed a definite list to one

side. The occurrence of the list toward or away from the affected side was about the same, and the writer was unable to attach any diagnostic significance to the direction of the list. Motions of the back were more free with the patient sitting than when he was standing. This agrees with previous observations.

TABLE VI

LIMITATION AND PAIN ON MOTION

	Number	*Percentage*
Limitation of straight leg raising:		
Unilateral	37	55.2
Bilateral	26	38.8
No limitation	4	5.9+
Pain on straight leg raising:		
Unilateral	41	61.2
Bilateral	20	29.8
No pain	6	8.9+
Pain on hip and knee flexion	8	11.9
Pain on adduction and internal rotation with flexion of hip and knee	15	22.3

Straight leg raising,—*i.e.*, flexion of the hip with the knee in full extension—was limited in all but six per cent. of the cases, and gave pain in all but nine per cent. In the majority of cases where there was bilateral limitation and pain on this manoeuver, the pain was referred to the affected joint.

Pain on flexion of the hip with the knee flexed was elicited in the extremely acute cases. A short period of rest in bed, usually on a Bradford frame, was sufficient to rule out disease in the lumbosacral region.

Hyperextension of the hip on the affected side was not carried out in a sufficient number of cases to warrant any conclusions in this report. The sign is apparently present frequently and may well serve as a diagnostic point.

Pain on forcible adduction and internal rotation of the hip, when both hip and knee were flexed, caused discomfort and pain in twenty-two and three-tenths per cent. of the cases, which places this as one of the important diagnostic signs. The reverse motion of abduction and external rotation was not as constant in producing pain, and it is not deemed of as much importance.

Stereoscopic roentgenograms were taken in all cases.

TABLE VII

ROENTGENOGRAPHIC FINDINGS

	Number	*Percentage*
Sacro-iliac region:		
Destruction	11	16.3
Irregularity	39	58.2
Increased density	38	56.7
Lumbar spine changes	10	14.9

In the eleven cases showing destruction in the joint, a definite lesion was found at operation in nine (13.4 per cent.). In cases where symp-

toms had been present for a long period of time, increased density about the joint was noticed. On the other hand, in over sixteen per cent. of the cases, increased density was found in the side opposite to that in which the symptoms occurred. The finding of irregularity and increased density seems to be of questionable value in the determination of sacro-iliac disorders. The changes in the lumbar spine consisted of marked congenital variations or degenerative arthritis, which were not considered to be the cause of the complaints.

Other forms of orthopaedic treatment were carried out in many cases before operation was advised.

TABLE VIII

PREOPERATIVE TREATMENT

	Number	*Percentage*
Sacro-iliac belt	40	
Back brace	3	
Special corset	2	
Rest in bed	11	79.1
Manipulation and plaster spica	4	
Manipulation without plaster spica	1	
No treatment	14	20.9

In addition to the above methods, heat, massage, and exercises were given to many of the patients. Rest in bed in these cases was carried out over a period of weeks with partial relief of symptoms, which later returned. Manipulation under anaesthesia in the five cases relieved the discomfort for a period of a few weeks or months, followed by a return of symptoms. Although manipulation and a long period of recumbency may relieve the symptoms in some cases, the writer believes that the quickest and most certain method of relief lies in operative treatment. The shortest period of palliative treatment was one week; the longest, five years; the average was four and six-tenths months. In fourteen (20.9 per cent.) cases, operation was performed within a few days after the first examination.

The posterior Smith-Petersen incision was used throughout this series. The motor saw was discarded after the first case. The block of bone can be cut out easily with thin sharp osteotomes of varying widths. The use of osteotomes does not require as large an incision in the soft parts as when the motor saw is employed. The point at which the joint line is reached can usually be ascertained by the change in vibration of the chisel and the change in pitch of the sound, as the wooden mallet strikes the chisel. The average size of the bone block employed was one by one and a half inches, measured on the face of the ilium.

TABLE IX

SACRO-ILIAC JOINTS FUSED

	Number	*Percentage*
Unilateral	57	85
Bilateral	10	15
Refusion	3	4.5

In the cases where a bilateral fusion was performed, symptoms and physical signs pointed to definite lesions on both sides. In six cases both sides were fused at one operation. In the other four a period of at least two weeks intervened between operations.

Refusion was performed in three cases, due to a return of the original symptoms and signs. In these cases at the second operation the original fusion seemed to be solid, the depressed area in the ilium had entirely filled in, and no motion could be found. The symptoms disappeared following the second operation. No satisfactory explanation has been found for this seeming discrepancy.

No definite pathology or mobility was found in fifty-six (83.6 per cent). Pathology was present in nine (13.5 per cent.). Excessive mobility occurred in two (2.9 per cent.). One of these was a far advanced tuberculosis of the sacro-iliac joint. The other followed a crushing fracture of the pelvis.

The after-care changed gradually throughout this series. In the first twenty-two cases a plaster spica was applied. Since August of 1927 plaster has been omitted. The length of postoperative care in this series can be definitely divided into two groups.

TABLE X

LENGTH OF ACTIVE POSTOPERATIVE TREATMENT

	Number	*Aver. no. of weeks after operation*
Fusion with plaster spica	22	28
Fusion without plaster spica	39	14.7
Unable to follow	6	

The writer believes that immobilization in plaster prolongs convalescence and delays the return to moderate activity.

The period of recumbency has been reduced from approximately twelve weeks to three and one-half weeks. The longest period was six months; the shortest, three weeks; the average was seven and one-half weeks. This average is higher than it should be, due to the twenty-two cases which were in plaster for a period of twelve weeks or more.

In the transition period between the use of plaster spicas and the shorter period of recumbency, thirteen cases received additional temporary support by the insertion of two beef-bone screws, parallel to the edge of the graft and about one centimeter distant from the edge of the graft, extending through the ilium well into the sacrum. Roentgenograms showed these to be absorbed in from three to six months. This procedure apparently did not influence the result in any way, and it has been abandoned.

Physiotherapy, in the form of heat and massage, was used in nearly fifty per cent. of the cases for a few weeks after discharge from the hospital. The larger proportion of the women wore corsets, either with or without a special sacro-iliac belt attached. A few of the men contin-

ued to wear a sacro-iliac belt which they had used prior to operation. The belts were discontinued gradually.

The end results cover periods from fifteen months to eight years following operation.

TABLE XI

TOTAL RESULTS

	Number	*Percentage*
Free from symptoms	46	68.65
Partial relief	12	17.90
No relief	2	3.00
Unable to trace	6	8.90
Dead	1	1.5

The cases listed as having received partial relief stated that the "old pain" had disappeared, and they complained of only indefinitely localized low backache without radiation. A few complained of pain in the scar for several months. Two cases have experienced no relief, but reoperation was not possible. The immediate results in the six cases which could not be traced were the relief of pain and the absence of symptoms. Five left the hospital symptom-free. One was discharged early against advice. One patient died of a generalized tuberculosis three months after operation. This man had an active pulmonary tuberculosis at the time of operation. Fusion was performed on account of the severe pain, unrelieved by other methods.

Referring to a former classification, there were eleven cases in which definite anatomical pathology was found. Fifty-six showed no changes in the joint at operation. The comparative results in these two classes are interesting.

TABLE XII

COMPARATIVE RESULTS

	PATHOLOGY		NO PATHOLOGY	
	Number	*Percentage*	*Number*	*Percentage*
Free from symptoms	7	63.63	39	69.64
Partial relief	2	18.19	10	17.86
No relief	0	0.00	2	3.57
Unable to trace	1	9.09	5	8.93
Dead	1	9.09	0	0.00
Total	11	100.00	56	100.00

The percentage of results is essentially the same, inasmuch as the one patient who died was relieved of all back symptoms for the remaining three months of life.

Active tuberculosis of the sacro-iliac joint should be treated by fusion, providing that the general physical condition is not a contra-indication. The presence of necrotic material in or about the joint has not hindered the process of fusion in our cases, and the end results have been as satisfactory as in the patients having a sacro-iliac strain.

Relief was secured in about eighty-two per cent. of the cases with anatomical pathology, and in about eighty-seven and five-tenths per cent. without anatomical pathology. The latter group with physiological pathology (if one may use that term) is the more common and, perhaps, the more important. If these percentages were figured on only the number of patients who were followed, ninety-six per cent. of the physiological cases would show relief. The writer believes, therefore, that considerable relief may be expected in at least ninety per cent. of all cases.

Sixty patients (89.2 per cent.) can be classified as to their ability to return to work. These percentages are based on the total number of patients (sixty-seven), and include those who could not be traced and the one who died.

TABLE XIII
FUNCTIONAL ABILITY

	Number	*Percentage*		
Returned to former work:				
Private and Ward	38	56.6	71.5	83.2
Compensation	10	14.9		
Returned to lighter work:				
Private and Ward	6	8.9	11.7	
Compensation	2	2.8		
Reported unable to work:				
Private and Ward	3	4.5		6.0
Compensation	1	1.5		

Basing these percentages on the sixty cases followed for a year or more, eighty per cent. were able to return to former work, thirteen and four-tenths per cent. to lighter work, and six and six-tenths per cent. reported that they were unable to work. An interesting point shown here is that the proportionate results between compensation cases and private and ward cases is the same. This was due, the writer believes, to the careful selection of compensation cases, excluding those who seemed anxious to secure an easy income by malingering, and those who had a definite traumatic neurosis.

Many classes of workers were represented, but they have been divided into three groups.

TABLE XIV
TYPE OF WORK

	Number	*Percentage*
Office	13	19.4
Housework	22	32.8
Industrial	25	37.3

Office workers included telephone operators, school teachers, clerks, etc. Housework varied from full-time active work to activities more social than laborious. Industrial work included plumbers, truck drivers, carpenters, and farmers, as well as day laborers.

The three cases in which a refusion was performed returned to work without symptoms. All three types of work were represented by these patients.

In two instances where a bilateral fusion was performed, it is interesting to note, the patients later went through an uncomplicated pregnancy and delivery without return of symptoms.

FINDINGS AND CONCLUSIONS

1. The chief value of roentgenograms is in the determination of a destructive lesion. Their value is questionable in other types of sacro-iliac disturbance.

2. A large percentage of patients were returned to work, eighty per cent. to their former occupation, and thirteen and four-tenths per cent. to a lighter form of work. Mortality was one in sixty-seven (1.5 per cent.); failure (unable to work) six and six-tenths per cent.

3. Sacro-iliac fusion is a satisfactory method of treatment both in strains and destructive lesions of the sacro-iliac joint.

4. Operation should be advised if, after a period of palliative treatment, the symptoms fail to subside or return after work is resumed. This applies particularly to the laborer who finds it impossible to change to a lighter form of occupation.

5. Fusion of the sacro-iliac joints apparently does not interfere with obstetrical delivery or render it more difficult.

6. Fixation in plaster, either with or without operation, prolongs the period of disability.

A considerable portion of this work has been done with the cooperation of Ralph R. Fitch, M.D.

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EXPERIMENTAL PRODUCTION OF ARTHRITIS BY ARTIFICIALLY PRODUCED PASSIVE CONGESTION*

BY MAURICE A. BERNSTEIN, M.D., F.A.C.S., CHICAGO, ILLINOIS

This article is a report on the experimental production of the lesions of chronic arthritis and the formation of new bone in dogs by means of artificially produced venous stasis.

So many factors are involved in the etiology of hypertrophic arthritis, or indeed in any type of arthritis, that any attempt directed towards the discovery of any proven causative influence is valuable.

The results of venous stasis in various parts of the body have been studied for many years. Much is yet to be learned. Common conditions almost invariably resulting from venous obstruction are sclerosis with atrophy, anaemia, and disturbance of calcium metabolism. In bone, or where osteoblastic cells occur, disturbances of ossification appear. In other tissues—as the kidney, for instance—marked sclerosis and atrophy are the rule.

Joint changes observed in hypertrophic arthritis are often suggestive of circulatory disturbances. Degenerative changes in the joints are the result of active congestion, such as is seen in the later stages of acute hyperaemia. Proliferative changes are observed in chronic inflammation with stasis. Vasomotor spasm acting through the sympathetic nervous system has also been responsible for joint changes.

Alterations in bones and in joints are often the result of cardiovascular and pulmonary diseases. Clubbing of the fingers or periarthritic thickenings in the terminal phalanges are noted in mitral stenosis and in chronic emphysema. Changes in the shafts of the long bones of the legs and in the smaller bones of the feet of a hypertrophic nature are noted as a result of varicosities.

Although hypertrophic enlargements of the transverse processes of the fifth lumbar vertebra are generally attributed to congenital causes, may they not be due to passive congestion resulting in osteogenesis? This stasis may be brought about by pelvic inflammation, tumors, enlargement of the gravid uterus, and also as a result of distensions of the caecum in chronic constipation causing interference in the hypogastric venous circulation.

Reasoning along these lines, it seemed to me highly probable that passive congestion or venous stasis was a factor in osteogenesis or new bone formation. In the furtherance of this idea I performed the following experiments.

In February and March of 1930, I operated on five dogs at the laboratories of the Northwestern University Medical School, through the courtesy of Dr. A. C. Ivy.

* Read before the Chicago Surgical Society, March 3, 1933.

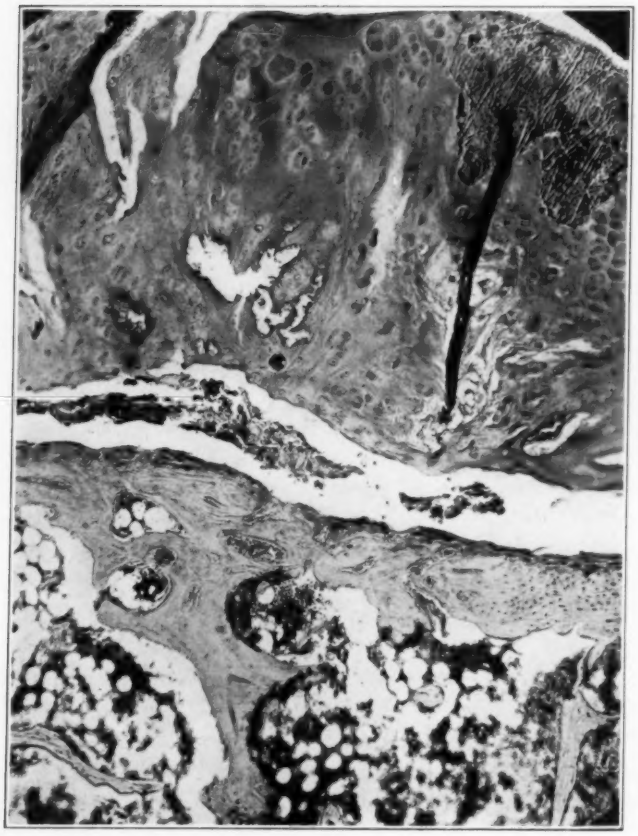

FIG. 1

Upper half of illustration shows the intervertebral space filled in by cartilage. This cartilage has replaced the fibrous tissue of the annulus fibrosus fibrocartilaginous intervertebralis and the nucleus pulposus and has extended beyond the intervertebral disc.

The dogs were anaesthetized and prepared aseptically for laparotomy. By the abdominal route the lumbar veins were exposed at their junction with the venae cavae. The visceral peritoneum was split by blunt dissection so as not to injure the sympathetic nerves, venae cavae, and abdominal aorta. Every precaution was taken to avoid injury to the nerve supply to the veins. Silk ligatures were placed on the veins, one above the other, to assure complete ligation. It was observed that the veins below the ligatures dilated immediately to about twice their normal size. All five dogs of this series were subjected to this same technique.

Dog 1, an adult male, died within four days after operation due to hemorrhages from the bowels. On postmortem examination it was found that there was considerable obstruction to the venous circulation.

The other dogs lived for two years—that is, until the first part of February, 1932—when they were killed, and their lower thoracic and lumbar spines removed for study. Each dog was roentgenographed at frequent intervals, from a period three months after operation until disposed of. The changes shown in the roentgenograms of some of the animals were those of rarefaction and decalcification, with loss of continuity of the bony outline at the anterior margins of the bodies of the vertebrae from the twelfth thoracic to the fifth lumbar.

FIG. 2

Shows two adjacent vertebrae with intervening intervertebral space. Note proliferation of cartilage cells, involving the nucleus pulposus, perforating the intervertebral disc, and extending into the body of the vertebra below.

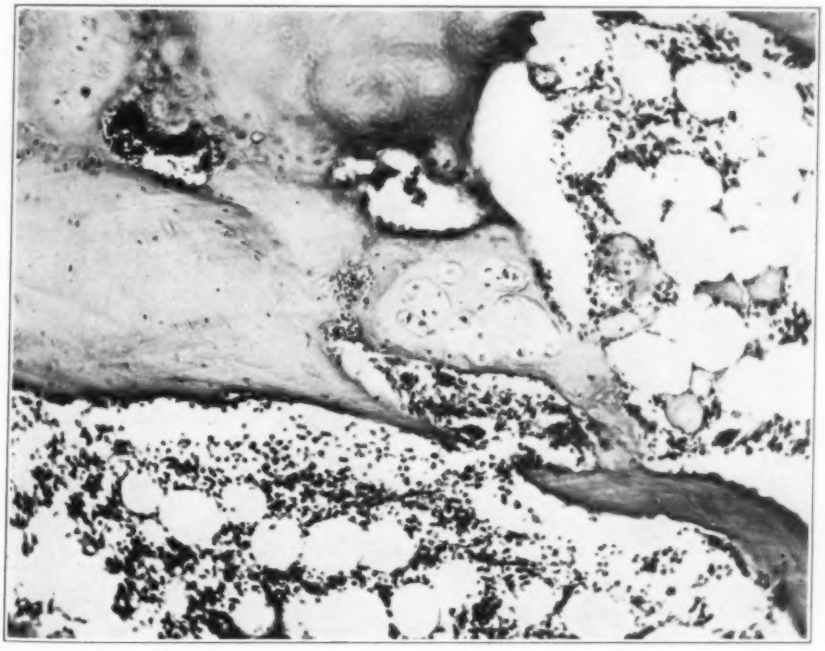

FIG. 3

Same as Fig. 2 (× 160), showing nests of cartilage cells bounded by mature bone. To the bone lamellae cling osteoblasts. Areas of bone absorption and new bone formation are in evidence.

FIG. 4

Bisected spine of Dog 5. It includes all of the lumbar spines and two and one-half of the dorsal. From above upward there appears a tumor-like bony outgrowth on the anterior surfaces of the vertebrae. This outgrowth of bone seems to extend from each body outward and forms a nodule which extends from one articular surface to the other. These nodules consist of young osteoid tissue with a loose fibrous stroma.

In the gross specimen, the spine of Dog 2 showed yellow patches in the marrow of the bodies, close to the articular margin. These patches were more or less irregular in outline and harder in consistency than the uninvolved bone. Some of these patches extended through the epiphysis and involved the nucleus pulposus and the annulus fibrosus fibrocartilaginous intervertebralis (Fig 1). Dog 3 showed only one lesion. This was a herniation, or, to be more exact, a proliferation of cartilage cells into the body of the third lumbar vertebra (Fig. 2). This change is unlike that described by Schmorl, in which the gelatinous nucleus pulposus herniates or is displaced as a result of pressure.

Dog 2 and Dog 4 showed practically the same changes. Dog 4 showed proliferation of cartilage in the intervertebral space to a greater degree than occurred in Dog 2. Islands of cartilage cells replaced fibrous tissue in the intervertebral spaces. The proliferating cartilage extended into the nucleus pulposus, forming nests of cartilage cells. Some of the bone trabeculae in the bodies underwent resorption with replacement by fibrous tissue and newly formed osteoid tissue.

Dog 3 (Figs. 2 and 3) showed in the intervertebral space between the second and third lumbar vertebrae a proliferation of cartilage cells, filling the intervertebral space, displacing the fibrous tissue at the periphery, and obliterating the nucleus pulposus. The intervertebral disc at the center of the upper border of the third lumbar vertebra was perforated by the cartilage-cell formation and these cells extended into the body of the vertebra, displacing the bone trabeculae and causing bone absorption at the point of cartilage extension. Giant cells were seen along the edges of the bone trabeculae. There was little change present in the spine of this dog beyond that stated above. The difference

between a herniated nucleus pulposus and the condition found above is that the cartilage proliferation filled most of the intervertebral space, perforated the intervertebral disc, and extended downward into the body of the vertebra. The herniated, or rather the proliferated, cartilage tissue does not resemble the tissue of the nucleus pulposus.

Lang[5] states "that in far advanced arthritis deformans, the so called cartilage nodules are observed; these are situated in the marrow spaces of the spongy bone". According to Pommer and Lang the cartilage nodules can originate in two ways: first, as callus resulting from microscopic fractures; and second, as fragments of joint cartilage that are broken off and transported as emboli along the capillaries and lymph vessels and grow where they lodge.

In the specimens of Dogs 2 and 3, the proliferation or extension of cartilage cells occurred at the points where the intervertebral disc was perforated. The cartilage cells extended from the region of the intervertebral space, where cartilage cells normally are found.

Dog 5 showed the greatest amount of change. Before the dog was killed, he experienced some difficulty in walking. He held his spine rigid and walked carefully. Muscle rigidity and immobility of the spine were present. On physical examination there appeared to be a marked infiltration of the tissues of the lower regions of the spine.

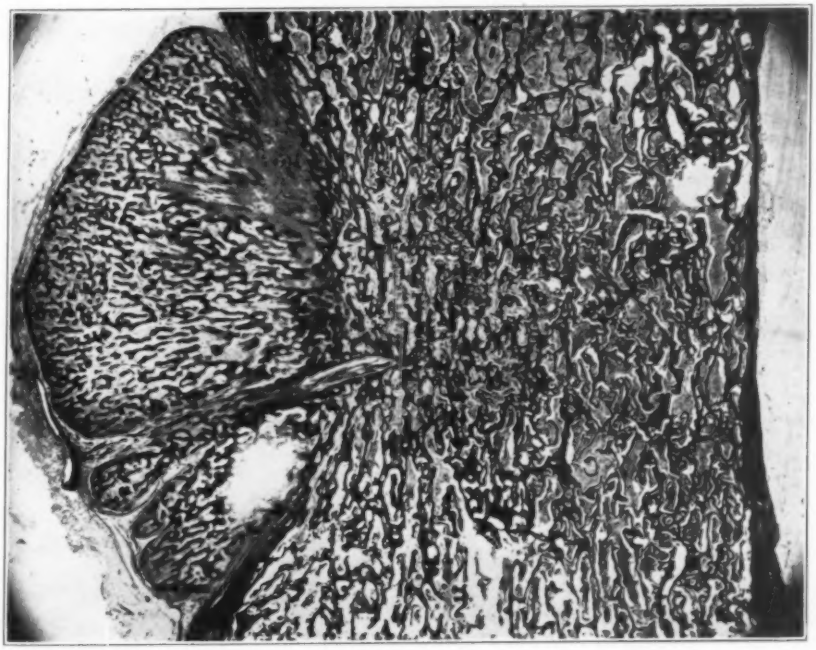

FIG. 5

Same as Fig. 4, showing one of the vertebrae with new bone formation on the anterior margin. Note the separation of these bony masses by fibrous tissue strands or septa.

The entire spine was removed for study and was bisected throughout its entire length (Fig. 4). Bony processes were found on the anterior surface of the twelfth thoracic vertebra and on each of the five lumbar vertebrae. This newly formed bone was well defined on the twelfth vertebra, and the bony processes on the other vertebrae progressively increased in size, so that those on the third and fourth lumbar vertebrae were of considerable size (Fig. 5). These processes seemed to extend out from the middle of the body, projecting beyond the surface of the vertebra and obliterating the anterior vertebral border. The color was pinkish yellow. Each bony process extended from one articular margin to the other, so that the full length of the vertebra on the anterior surface was covered by this osteoid tissue. These bony masses were almost alike in form, the third and fourth lumbar vertebrae having the largest growths upon them. There appeared to be no bridging across the intervertebral spaces from vertebral border to adjacent vertebral border, such as one sees in osteo-arthritis. The processes seemed to have originated from within, and to have extended outward beyond the surface of each body. The bony processes in the third and fourth lumbar bodies seemed to be divided into two or three bony masses by connective tissue septa, which could be made out with the naked eye.

On microscopic examination these bony masses were found to be composed of osteoid tissue. This tissue was arranged in masses separated by a loose fibrous stroma (Fig. 6). In some places bone trabeculae could be seen to project into the fibrous stroma, and these trabeculae were lined with osteoblasts (Fig. 7). The processes in the third, fourth, and fifth lumbar vertebrae appeared to be quite far advanced and islands of mature bone were abundant. The osteoid tissue showed no lime deposit, staining red with hematoxylin and eosin. The twelfth thoracic and the first lumbar vertebrae showed more progressive changes. The young osteoid tissue was not so far advanced in the development as it was in the lower lumbar vertebrae. Here the fibrous stroma was more abundant. However, the fibrous tissue was quite generally distributed, and was permeated by the osteoid tissue which spread out in every direction. In the center of the bodies the mature bone showed regions of bone absorption and this same variety of osteoid tissue lying between a loosely arranged fibrous stroma.

One received the impression that there were three processes actively present,—first, bone absorption (an osteolysis); second, a fibrous tissue proliferation; and third, a metaplasia of connective tissue with new bone formation (osteogenesis).

It was decided to attempt, by passive congestion, to produce changes in a joint that could be studied with more ease than could the joints of the spine. The knee was selected, therefore, and in June, 1931, Dog 6 was operated upon by ligation of the branches of the femoral vein above the knee joint.

The knee was prepared as usual by shaving and aseptic measures. Ether anaesthesia was used. An incision was made on the inner side of

FIG. 6

Same as Fig. 5 (× 40), showing the bony structure and fibrous tissue strands which separate the osteoid tissue.

FIG. 7

A portion of Fig. 6 (× 80). Note the osteoid tissue and mature bone. Note also the extensive fibrous stroma, the bone trabeculae, and osteoblasts clinging to the surface. There is also present considerable vascularization.

the joint above the patella. The branches of the femoral vein, which drain the knee, were isolated and ligated. No oedema or apparent disability followed this operation. This dog (Dog 6) was kept alive until March 1932. A roentgenogram of both knees was taken in the early part of March. The operated knee showed some indefinite changes on the articular surface of the femur,—a rarefaction in the outer condyle. There was no evidence of destruction of the articular cartilage and no new bone formation. The patella presented irregularity of its margins with a loss of surface continuity.

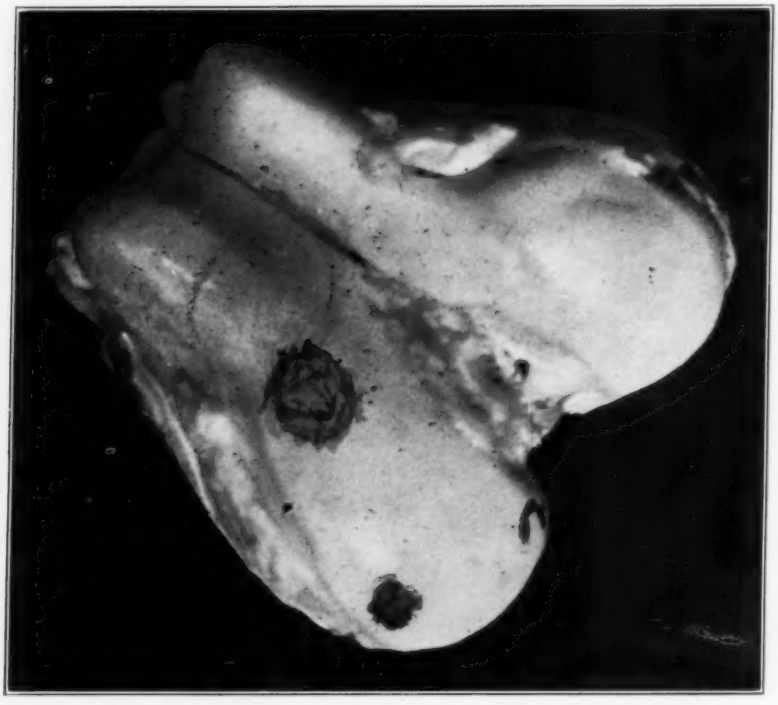

FIG. 8

Photograph of condyles of femur showing three lesions. The one on the outer condyle to the left and below shows a rounded depressed area of the articular cartilage, with the subchondral vessels showing through. The small horseshoe-shaped area on the inner side of the condyle contained a necrotic bit of material; after its removal it left a defect as in Fig. 9. The area above the condyles was discolored but not depressed and showed the vessels through.

The dog was then killed and both knee joints were opened for study. The knees were opened by cutting the quadriceps tendon; the patella was dissected downward; all care was used not to injure the articular cartilage surfaces.

The knee that was operated on presented a striking appearance. The synovial membrane and fat pad showed congestive changes; these were evident by hyperaemic areas at the borders of attachment to the articular margins of the femur and tibia. On the synovial membrane

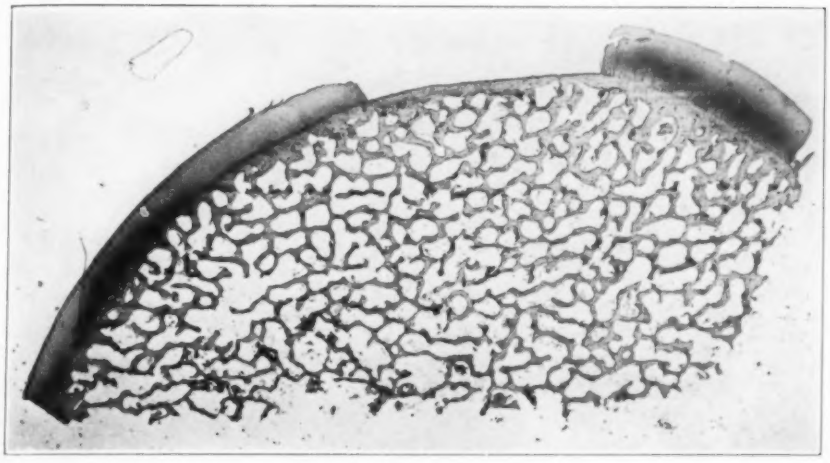

FIG. 9

Photograph of the articular margin of the femur in Fig. 8, showing a defect which looks like an artefact. This is due to the removal of the necrotic mass, leaving a thin portion of cartilage covering the bone.

surface, close to the intercondylar notch, were seen patches of fine web-like granulation tissue. This pannus spread over the articular cartilage of the outer condyle bordering on the attachment of the crucial ligament and extended to a defect in the cartilage to which it was attached at one point. The fat pad also showed areas of increased vascularization. These appeared as red streaks. The congestion extended to the ligamentum mucosum at the intercondylar notch.

The articular cartilage on the external condyle of the femur showed three lesions (Fig. 8). One lesion, lying immediately above the lower surface, was about two centimeters in circumference, round, depressed, with edges well defined, and slightly elevated. The cartilage on the surface appeared as if it had been shaved off or worn through, leaving a bluish surface through which could be seen the subchondral vessels.

A second lesion was seen on the inner surface of the condyle, at the attachment of the crucial ligament. This lesion was punched out and contained a dark clot-like mass of necrotic material. When this was removed it left a definite defect, irregular in outline, with sharp borders. Pannus from the synovial membrane extended to the border of this defect.

The third lesion was in the region above the condyle and was not ulcerated or depressed, but was slightly discolored, bluish gray, and the vessels of the subchondral bone could be seen through it.

Microscopic examination of the lesion on the inner border of the external condyle revealed a loss of continuity of the surface (Fig. 9). There appeared in this area an absence of articular cartilage surface leaving a crater-like defect. A thin layer of cartilage still remained, covering the subchondral bone. The area looked very much like an artefact, but this was perhaps due to the wiping out of the necrotic ma-

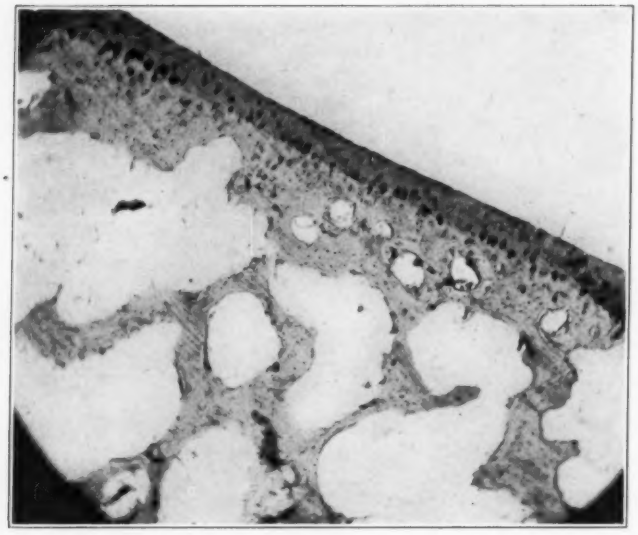

FIG. 10

A portion of the articular cartilage of the knee joint (× 40), showing the articular surface markedly decreased in diameter. Note the perpendicular arrangement of the cartilage cells on the surface, the enlarged blood vessels, and the atrophied bone trabeculae. Compare with Fig. 11.

terial that filled it. In this region the surface cells were completely gone. The cells that remained covering the bony surface appeared shrunken and denucleated. The spongiosa showed an absence of lime salts, and the bone lamellae showed areas of osteolysis. The marrow spaces contained fat. In the other of the two areas the articular cartilage surface cells were destroyed, leaving a thin rim of cartilage covering the end of the bone (Fig. 10). This area bordered upon practically normal-appearing cartilage on both sides of the defect (Fig. 11). The surface cells in the depressed region lay perpendicular; those at the adjacent cartilage were parallel, showing that the surface cells were removed. In the subchondral region there were seen numerous blood vessels. The marrow spaces contained fat; there were no osteoblasts nor osteoclasts present. These defects were crater-like, and involved about four-fifths of the articular cartilage. A thin layer of cartilage yet remained and formed the base of the ulcer, which rested upon the decalcified, fatty, atrophic bone. In some places the cartilage cells were denucleated, and extended to the edges of the defect. The cells in the uninvolved region lay parallel to the surface, which is the normal arrangement of the superficial cells of the perichondrium. As the involved region was reached these surface cells disappeared, perhaps by chondrolysis, leaving the cells of the deeper strata perpendicular in arrangement. At this time no attempt at healing appeared, and no sign of inflammation was evident, excepting that the vessels in the bone below the cartilage were enlarged and numerous. The lesion in the center of the articular cartilage on the outer condyle of the femur was found where the greatest amount of pressure of apposing articular cartilage occurs. It may be possible that the thinning of the articular cartilage surface occurred first from softening as a result of circulatory disturbance; or, as Pommer states, from "loss of elasticity of the joint cartilage", or, according to Phemister[3], as a result of

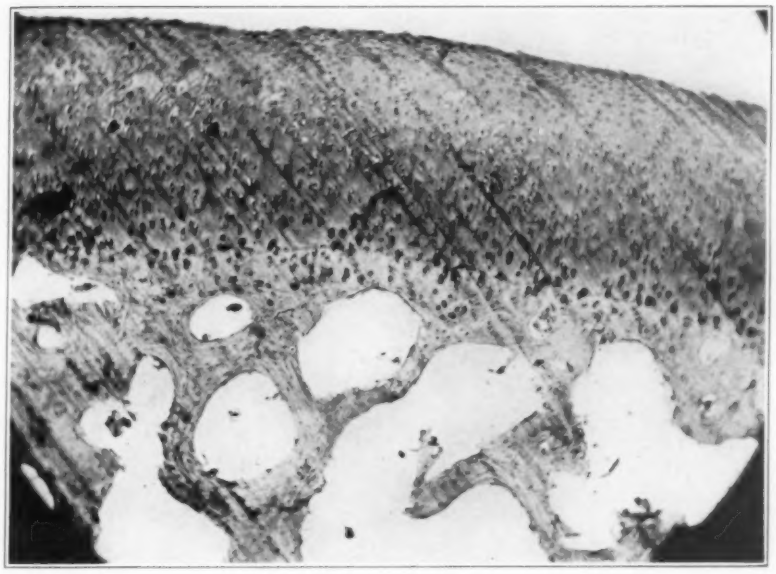

FIG. 11

Same as Fig. 10; a different portion of the articular cartilage away from the depressed region shown in Fig. 10. Note the parallel arrangement of the surface cells of the perichondrium.

contact and pressure of, or wearing down of, the articular cartilage surface.

It is my belief that these defects, if permitted to progress, would eventually become covered over by fibrous tissue derived from the edges of the synovial membrane. This belief is based upon the changes which were found in the synovial membrane bordering on the ulcerations. The synovial fringes were hyperaemic, and thickened, and showed a tendency towards pannus formation. Also, the patella showed a degenerative change, in that its edges were irregular, and its surface presented a loss of continuity. Microscopically, it presented a loss of lime deposits, and atrophic bone trabeculae with fatty marrow spaces.

Thus, there were present a destruction or ulceration of the articular cartilage of the femur and a chronic hyperplastic synovitis. The changes in the articular cartilage of the femur were of a chondrolytic nature.

In March, 1932, two more dogs were operated on in a manner similar to that used for Dog 6. The branches of the femoral vein above the knee joint were ligated. The dogs were kept alive for two months and were then killed.

The knee of Dog 7 was then opened and showed (Fig. 12) a defect of the articular cartilage on the outer condyle of the femur. This defect was irregular in outline and bordered upon the synovial membrane surface, close to the intercondylar notch. Small grayish patches were present in the synovial membrane surface. These looked like calcified areas.

FIG. 12

Dog 7. Defect on outer condyle of femur produced by ligation of femoral vein branches. Dog was kept alive for two months. Note widespread calcified areas (the chalk-like flakes in the photograph).

The synovial membrane itself showed hyperaemic areas. Microscopically there was present no inflammatory reaction in the articular cartilage, nor in the spongiosa. The bone trabeculae, however, appeared decalcified and atrophic and showed areas of degeneration. These changes were somewhat like those found in Dog 6.

Dog 8 developed a severe case of mange and died. The knee of this dog was not investigated.

SUMMARY AND CONCLUSIONS

In these experiments changes were produced of a regenerative nature in the spines, and of a degenerative nature in the knee joints of dogs. The changes in the spine were cartilage proliferation and new bone formation. In each of three dogs the changes took place in the intervertebral spaces and in the fibrosus annulus intervertebralis. Islands of cartilage cells were seen in the bodies at their peripheries and below the intervertebral discs. In the spine of one dog there was a proliferation of cartilage into the body of the third lumbar vertebra and formation of osteoid tissue. In one dog masses of new bone were found on the anterior surfaces of five lumbar and one thoracic vertebrae. In this dog young osteoid tissue and new bone were present in the body and extended beyond the anterior surface. The changes were more pronounced in the lumbar vertebrae and corresponded to the region of the ligated veins.

Microscopically there was shown a proliferation of cartilage cells, and these cells were distributed irregularly through the bone trabeculae. Osteoblasts were present on the borders of the osteoid tissue, and in other regions nests of osteoclasts were evident. The marrow spaces contained fat, and the hemapoietic tissue was decreased in amount. In other regions the trabeculae appeared to be normal with some increase of the intercellular elements.

The dogs of this series were all kept alive for practically the same length of time,—that is, two years; so that the bone changes were of the same duration. Dog 6 and Dog 8 were the only animals kept alive for a

shorter period,—*i.e.*, two to six months; so that in these dogs were not seen the advanced processes present in the others. One may deduce from these experiments that proliferation, or rather new bone formation, resulted from venous stasis. The control animals showed no such changes.

I wish to extend my gratitude to Dr. R. F. Zeit and Dr. A. C. Ivy for the materials used at Northwestern University Medical School, and the assistance given me in the furtherance of these experiments.

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LEG LENGTHENING IN ADULTS

BY JOSEPH S. BARR, M.D., AND FRANK R. OBER, M.D.,

BOSTON, MASSACHUSETTS

The procedure known as leg lengthening has become standardized to such an extent that it is being used in most of the larger orthopaedic clinics. The original work of Codivilla[1] and Putti[2] gave proof that the operation was feasible. It remained for Abbott[3] to devise a simple dependable apparatus and to standardize the operative procedure. Since his first report, in 1927, of six cases successfully lengthened, the method has been used on literally hundreds of children. In well selected cases the operation has proved itself safe and worth while. However, a careful review of the literature reveals that the cases reported as lengthened by the Abbott method are, without exception, children under the age of sixteen. There are a few isolated case reports of malunited overriding fractures of the femur in adults being reduced by heavy skeletal traction, but no series of cases has been found in which shortening due to unequal growth of the legs was overcome.

Magnuson's[4] experimental work proved that about two inches could be safely obtained. The purpose of this paper is to report five young adult cases in which leg lengthening has been done. In each, the cause of the shortening was infantile paralysis.

Figure 1 shows the leg-lengthening apparatus as used at the present time. The technique of lengthening as used in these cases is essentially that of Abbott, but the apparatus has been altered somewhat. Each of

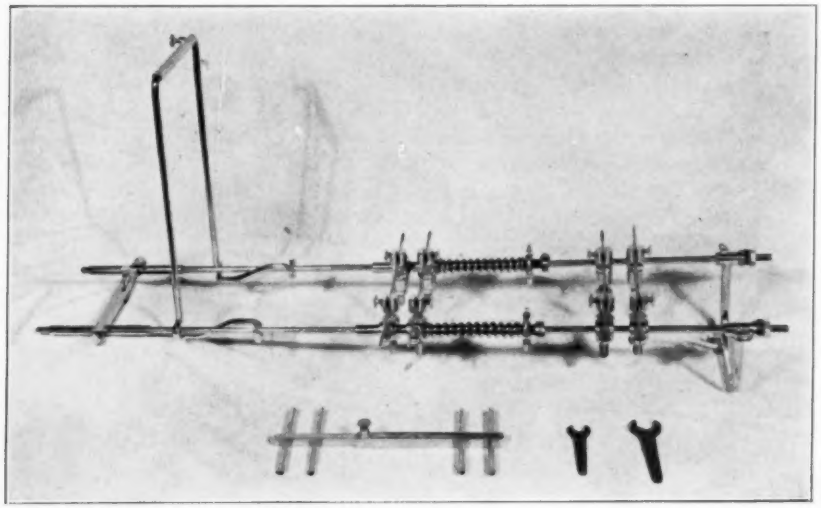

FIG. 1

Leg-lengthening apparatus.

the pins is movable at either end, so that any tendency of the bone fragments to angulate can easily be overcome by the proper adjustment.

The tendency of the foot to assume a position of equinus and valgus during leg lengthening has been noted by every one who has had experience with this procedure. This occurs in spite of tenotomy or lengthening of the tendo achillis and double osteotomy of the fibula. For this reason it is best to defer stabilizing operations on the foot until the leg lengthening has been done. The foot can then be placed in the correct weight-bearing position.

Case 4 in this series developed such an equinus during leg lengthening that a reconstructive operation on the foot was necessary. An ordinary foot rest will not prevent the occurrence of this deformity. To overcome this difficulty, a plaster boot, incasing the foot and extending up the posterior calf, has been tried in two cases. In addition, an attempt has been made to overcome the tendency to valgus deformity of the foot by turning up the outside turnscrew about one-eighth of an inch more than the inside one, which tends to force the foot into a little varus. This procedure has been successful in holding the foot in the correct position in the two cases in which it has been used.

CASE REPORTS

Case 1. M.E.W. This patient was a single white girl of twenty. She was first seen on June 5, 1919. She had had infantile paralysis when two years old, involving chiefly the left leg. Progressive shortening of the leg occurred until, when seen in 1928, the left leg was found to be two and three-quarters inches shorter than the right, as measured from the anterior-superior spine to the sole of the foot. She used a long caliper brace and a two-inch cork high sole.

Leg lengthening was done on June 19, 1928, and at the same time transplant of the flexor communis digitorum to the os calcis was done. Abbott's method of leg lengthening was used. Convalescence was uneventful. On August 10, 1928, the leg-lengthening machine was removed and a cast applied. Union was somewhat delayed, due to slow callus formation, and the patient began to walk with a brace September 19, 1929. There was shortening of the leg of one-quarter of an inch at that time. In December 1929, the patient felt some pain in her left leg and x-rays showed a subperiosteal transverse fracture of the left tibia at the junction of the lower and middle thirds. On February 28, 1930, x-rays showed the fracture completely healed. On May 21, 1930, an osteotomy of the left tibia just below the knee was done to correct the knock-knee. Convalescence was uneventful. The patient was last seen September 14, 1931. The left leg was one-quarter of an inch short. She walked with practically no limp without a brace, but had not yet been able to completely discard it due to the weak quadriceps. She was much pleased with the result, as she was freed from the necessity of using a high sole and rarely used a brace.

Case 2. M.M. This patient was a single white girl of twenty-nine, first seen on November 16, 1929. She had had infantile paralysis when thirteen months old, involving her left leg only. The patient wore a long brace with an inside sole plate and a shoe with a three-inch cork sole. The leg was three and one-half inches short, as measured from the anterior-superior spine to the sole of the foot. Most of the shortening was in the lower leg. There was sufficient quadriceps and hamstring power to justify an attempt to get rid of the brace and high sole by leg lengthening.

On December 2, 1929, leg lengthening was done after the method of Abbott. The lengthening was begun seven days after the operation and was stopped on February 1,

1930, at which time a gain of two and one-quarter inches had been made. The leg-lengthening machine was removed and a plaster cast was applied from the toes to the groin on February 15, 1930, which was worn for twelve weeks. When seen in November 1931, she was working, without apparatus, standing on her feet a great deal. She walked with her knee held quite stiffly, due to fifteen degrees' permanent knee flexion. This has been corrected by osteotomy of the upper end of the tibia. When last seen she was walking two or three miles daily without aid, except for occasional use of a cane. She was entirely satisfied with the result, as she had been enabled to discard a long brace and a heavy high sole by the operation. The leg was in good alignment, one and one-quarter inches short. As part of the shortening was compensated for by equinus of the foot, she was able to wear an ordinary shoe.

Case 3. W. H. was a single white boy of eighteen. He was first seen on May 25, 1921. He gave a history of having had infantile paralysis when he was a year and a half old. Both legs were affected, but the left one had returned practically to normal. The right leg required a long brace. He was carried along under conservative treatment, physiotherapy, and exercises, and a long caliper brace on the right, until July 7, 1930, when a right erector spinae transplant (Ober[5]) was done. Postoperative recovery was uneventful, and on July 23, 1930, a Hoke arthrodesis and countersinking of the astragalus (Brewster[6]) was performed on the right foot. At the same time a plastic operation, after the method of Gill[7], was done on the knee for recurvatum.

When seen on February 24, 1931, the foot was in good position; no hyperextension of the knee was permitted; the erector spinae transplant was functioning well; and the gluteus maximus and medius limp had practically been overcome. The right leg was found to be three inches short, and it was decided to do a leg lengthening. This was done on March 30, 1931, after the method of Abbott. A plaster boot, incasing the foot and extending up the posterior calf almost to the knee, was applied after the operation. This held the foot in neutral and prevented the occurrence of equinus deformity as the lengthening proceeded. The lengthening apparatus was removed May 28, 1931, and a plaster cast applied, which was removed December 2, 1931. The leg was quite solid in good alignment. There was no shortening,—*i.e.*, three inches had been gained in length. The patient is now walking about two miles daily, using a cane part of the time. He walks well and uses no apparatus.

Case 4. G.S., an unmarried white girl of twenty-three, was first seen on June 11, 1930. She had had an insidious onset of paralysis of her right leg when nine months old. The patient wore a long, right, caliper brace and a shoe with a cork sole, three and a half inches high. The leg was four and one-eighth inches short, all but one and one-half inches of the shortening being in the lower leg. The quadriceps was strengthened by transplant of the sartorius and tensor fasciae femoris to the patella on October 17, 1930.

On November 14, 1930, the right leg was operated upon after the method of Abbott. The lengthening was begun eight days later. It proceeded smoothly, and the lengthening was stopped on December 30, 1930. The apparatus was removed on January 23, 1931, and a plaster cast applied from the toes to the groin. The cast was removed March 23, at which time it was found that union of the leg was quite solid. There was a total gain of two and five-eighths inches in length. The knee transplant functioned well. The foot, which before operation had been in very slight equinus, was now in forty-five degrees' equinus, making it practically impossible for the girl to wear a shoe. On May 25, 1931, a wedge osteotomy of the foot in the mid-tarsal region was done and a plaster cast applied. This was removed six weeks later and weight-bearing with crutches was started. When seen in January 1933, the right leg was found to be one and one-quarter inches short, measured to the sole of the foot. This was partially compensated for by the remaining mild forefoot equinus. She now walks without a brace or high sole, with the occasional aid of a cane. She is greatly pleased with the result.

Case 5. M.H. This patient was a single white girl of twenty-six, who had infantile paralysis in 1908. About ten years ago an astragalectomy for a flail left foot was done

with an excellent result. She had three inches' shortening of the left leg, and walked with a marked short leg and gluteus medius limp.

On January 23, 1929, the left leg was lengthened after the method of Abbott. The apparatus was removed and a plaster cast applied April 11, 1929. She began weight-bearing about six months later. When last seen, August 6, 1931, there was one inch shortening of the left leg as measured from the anterior-superior spine to the sole of the foot. The foot was in excellent position, quite stable. She walked without apparatus in ordinary shoes. The gluteus medius limp was still present. She was well satisfied with the result, as she was enabled to discard an unsightly high sole by the operation.

The average period of disability due to the operation in this group of cases was nine months; the maximum was fifteen months; the minimum, five months. There were no deaths and no sepsis occurred. As compared with younger children, the lengthening must proceed a little more slowly and there seems to be a little more pain and discomfort during the lengthening. No case, however, required more than an occasional dose of morphin, and most of them required neither hypnotic nor sedative after the first week postoperative. Pain during the lengthening is usually referred to the lateral aspect of the ankle and dorsum of the foot, suggesting that the stretching of the peroneal nerve is the cause. One or two days' rest relieved the symptoms as a rule.

TABLE OF CASES

Case	*Age*	*Shortening*	*Lengthening Obtained*	*Complications*	*End Result*
1. M. W.	20	2¾ inches	2¼ inches	Fracture of tibia 1½ yrs. after lengthening	Good. Walks without apparatus.
2. M. M.	29	3½ inches	2¼ inches	None	Excellent. Patient discarded long brace and high sole.
3. W. H.	17½	3 inches	3 inches	None	Excellent.
4. G. S.	23	4⅛ inches	2⅝ inches	Foot developed marked equinus	Excellent. Patient discarded long brace and high sole.
5. M. H.	26	3 inches	2 inches	None	Good.

The proper selection of cases is of great importance. It does not seem worth while to lengthen a leg which has insufficient muscle power to discard a brace after the operation. It seems best suited to those cases which will be enabled by the lengthening, and other operations if necessary, to discard all apparatus on that limb.

It goes without saying that the cooperation between patient and surgeon should be perfect. The surgeon should explain the procedure to the patient as carefully as possible, estimating the period of disability as about one year. The dangers as well as the benefits should be weighed carefully and the patient should be allowed to decide without urging the case for or against lengthening.

In the small series here reported, no case has been "lost track of" or has been uncooperative. Each one has been enabled to discard a brace or high sole or both with consequent cosmetic and functional improvement. The follow-up examination has shown a satisfactory result in each case, and each patient has expressed himself as satisfied with the result.

CONCLUSION

From the experience gained with this small group of cases, it seems justifiable to conclude that leg lengthening in adults will yield gratifying results if the patients are properly selected and the technique of the lengthening and after-care is properly carried out.

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ENLARGEMENT OF THE INTERVERTEBRAL DISC ASSOCIATED WITH DECALCIFICATION OF THE VERTEBRAL BODY: A COMPENSATORY HYPERTROPHY

BY BARCLAY W. MOFFAT, M.D., NEW YORK, N. Y.

From New York Post-Graduate Hospital

It has been noticed by all orthopaedic surgeons that a roentgenogram of the spine occasionally will show an increase in height of the intervertebral disc, this structure assuming a biconvex form. The significance of this change and the mechanism by which it comes about have not been investigated.

In the following five cases these changes in the shape of the intervertebral disc were most marked and were accompanied by decalcification of the vertebral bodies. These patients all came complaining of backache, following slight trauma in four cases, and none in the other. Beside the above changes, by x-ray there was found to be fracture of one or more vertebral bodies as the source of the pain complained of. It is logical to assume that these fractures were associated with the underlying condition in the spine which led to the decalcification and to the increase in size of the intervertebral disc.

These five cases are outlined below with a brief discussion of the etiological factor, where it could be determined, and the process taking place in the disc which caused it to assume biconvex to spherical shape. It seems a point worth noting that, in the absence of any local pathology, such as osteitis or neoplasm, a pathological fracture of the spine may take place through faulty metabolic processes.

CASE 1. Male, aged sixty-four, admitted August 5, 1928, complained of pain in the back for the past five years and in the hips for the past ten years. Examination was negative. Roentgenograms taken at this time are reproduced (Figs. 1 and 2). On December 19, 1928, patient was readmitted with paraplegia and loss of sphincter control. No x-rays could be taken at this time because of the patient's condition. Neurological examination made it probable that the man had sustained fresh fractures of the lumbar vertebrae with a transverse myelitis. He died of hypostatic pneumonia and a section of a portion of the spine, removed at autopsy, is shown (Fig. 3). A microscopic examination established a diagnosis of multiple myeloma.

CASE 2. Female, aged fifty-six, complained of pain in the middle of the back radiating about both sides of the abdomen, following a jolt while riding over an uneven road. Physical examination was negative except for tenderness over the first lumbar vertebra where compression fracture was found (Fig. 4). Patient died within a few days and autopsy disclosed rupture of the aneurysmal varix. A specimen of the spine was not obtained.

CASE 3. Female, aged sixty-one, admitted June 12, 1927, complained of pain in the back following a fall six weeks before. Examination was negative except for evidence of root involvement over the distribution of the first lumbar vertebra (protopathic) and twelfth dorsal and second lumbar vertebrae (epicritic). Roentgenograms taken at this time are reproduced (Figs. 5, 6, and 7). The basal metabolic rate was plus five per cent. Sugar tolerance test was slightly diminished.

FIG. 1

Lateral view of spine of Case 1 showing diminution of height of vertebral bodies and increase of intervertebral discs.

FIG. 2

Anteroposterior view of Case 1.

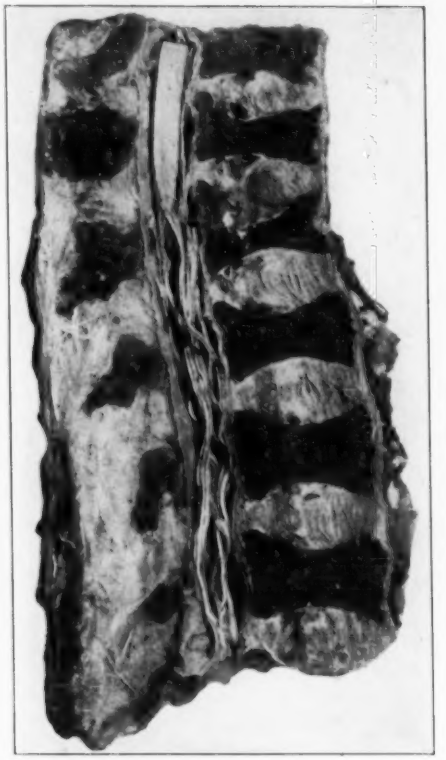

FIG. 3

Photograph of section of spine shown in Figs. 1 and 2.

Blood chemistry findings (fasting) were as follows: sugar, 93.5 milligrams per 100 cubic centimeters; urea, 13.6 milligrams; uric acid, 215 milligrams; calcium, 7 milligrams.

The woman was readmitted May 14, 1930. In the interval patient had been receiving parathyroid at the advice of a local physician. Examination at this time showed: Blood chemistry (fasting): sugar, 82.5 milligrams per 100 cubic centimeters; urea 11 milligrams; uric acid, 1.7 milligrams. Two hours after the injection of 100 grams of glucose, the sugar was 127 milligrams; four hours after, the sugar was 87.5 milligrams and the calcium 11.3 milligrams. The basal metabolism at this time was minus thirty per cent.

X-rays on this admission showed further decalcification of the body of the vertebra and increase in height in the intervertebral disc. Phosphorous and calcium balance are reproduced.

FIG. 4

Lateral view of spine of Case 2 showing fracture of a vertebral body.

REPORT OF LABORATORY EXAMINATION

Patient	*Examination Made*	*Report Made*
Name, Case 3. *Age* 63	May 2 and 3, 1930.	May 15, 1930.

Examination Required: Calcium balance for 24 hours.

Result of Examination

Blood:

Calcium as Ca	10.8 mg. per 100 c. c.
Phosphorus as P	3.9 mg. per 100 c. c.
Fibrin	0.4 per cent.
Albumin (serum)	5.5 per cent.
Globulin (serum)	2.7 per cent.
Total serum proteins	8.2 per cent.

Intake in Food:

Calcium as CaO	1.08 grams
Phosphorus as P_2O_5	2.28 grams

Excretion:

Urine—	Volume	710 c. c.
	Sp. Gr.	1.010
	CaO	0.12 grams
	P_2O_5	1.34 grams
	MgO	0.16 grams
Feces—	Weight	110 grams
	CaO	1.08 grams
	P_2O_5	2.38 grams
	MgO	0.48 grams

Microscopically: No fat, no soap, some vegetable fiber.

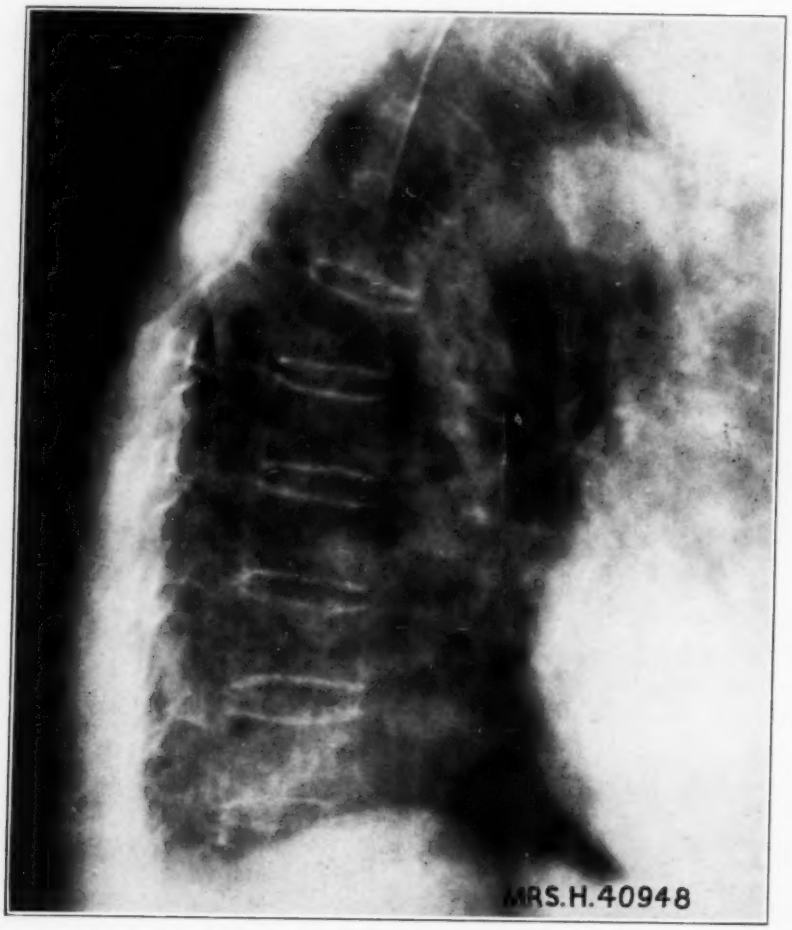

FIG. 5
Lateral view of the dorsal spine of Case 3.

REPORT OF LABORATORY EXAMINATION (*Continued*)

Calcium Balance:

Intake in food	1.08 grams CaO	Ratio $\frac{\text{CaO in urine}}{\text{CaO in feces}} = \frac{1}{9}$
Output in feces	1.08 grams CaO	
Output in urine	0.12 grams CaO	
Balance	−0.12 grams CaO	

Phosphorus Balance:

Intake in food	2.28 grams P_2O_5	Ratio $\frac{P_2O_5 \text{ in urine}}{P_2O_5 \text{ in feces}} = \frac{1.0}{1.7}$
Output in feces	2.38 grams P_2O_5	
Output in urine	1.34 grams P_2O_5	
Balance	−1.44 grams P_2O_5	

Magnesium Excretion: Ratio $\frac{\text{MgO in urine}}{\text{MgO in feces}} = \frac{1}{3}$

FIG. 6

Lateral view of the lumbar spine of Case 3 showing changes noted in text. The decalcification is especially marked in this case.

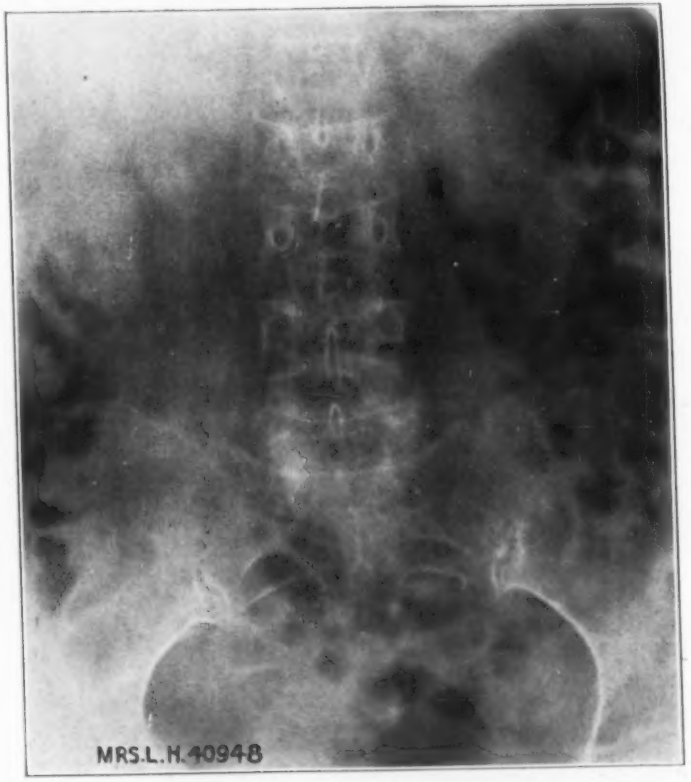

FIG. 7

Anteroposterior view of lumbar spine of Case 3.

FIG. 8

Lateral view of the dorsolumbar region of the spine of Case 4, showing compression fractures of the bodies of two vertebrae.

CASE 4. Female, aged sixty-one, complained of pain in the back, the result of a jar she received while riding over an uneven road, two years before. Roentgenograms of this patient are reproduced (Figs. 8 and 9).

CASE 5. Male, aged nineteen, complained of pain in the back with no history of trauma. The roentgenograms are reproduced (Figs. 10, 11, and 12).

Physical examination: Boy was typically of the pituitary dystrophic type. Spine was kyphotic about the twelfth dorsal vertebra. Sugar tolerance test confirmed the diagnosis of hypopituitarism. During his stay in the hospital, patient passed some blood in the urine which was unexplained by pyelogram and cystoscopy. Patient was given parathyroid and calcium lactate and discharged three small calculi. He was discharged from this hospital to the care of the writer at another hospital where his medication was continued. From this latter hospital he was discharged to his home to remain in bed. However, on the second day after discharge, the patient decided to dress and died of acute dilatation of the heart. No autopsy was allowed.

The study of these cases was undertaken in an attempt to discover what had happened to the spine and why. The process seemed to be one of osteoporosis of the bodies with secondary changes in the intervertebral discs. Obviously, the body changes were due either to replacement of the normal bony tissue by malignant cells, or to decalcification. In Case 1 autopsy showed the first of these conditions to be present, but it was ruled out in the others. In these latter cases, where it was possible, a study was made to determine the cause of the loss of calcium from the vertebral body and in one, Case 3, the evidence would point to a faulty diet as the cause of the loss of calcium from the spinal column. In another, Case 5,

there was definite evidence of pituitary dysfunction.

The assumption of the spherical form by the disc has been attributed by Schmorl, who of the various observers has written most extensively of this condition, to expansion of the nucleus pulposus, due to release of pressure, the result of softening of the adjacent bodies. As the cause of this latter condition, Schmorl suggests chronic disease.

FIG. 9

Lateral view of the lumbar spine of Case 4 showing typical changes.

It would seem to the writer that there are several aspects which suggest that the process is one of compensatory hypertrophy, rather than release of pressure from an elastic nucleus.

First: The disc shown in Figure 11, which is almost globular, would suggest an extraordinary degree of expansibility of this nucleus, were this the true cause of the enlargement. Moreover, as Schmorl has pointed out, this nucleus is seldom to be found centrally located in the disc, which would again make unlikely the assumption of so nearly spherical a form.

Second: In the sections shown by Sicard, Belot, Coste, and Gastaud, their Case 2 shows intact discs in spite of collapse of the adjacent vertebral body by metastatic cancer; whereas their Case 3 shows enlargement of the discs with invasion, also by metastatic cancer of the adjacent bodies.

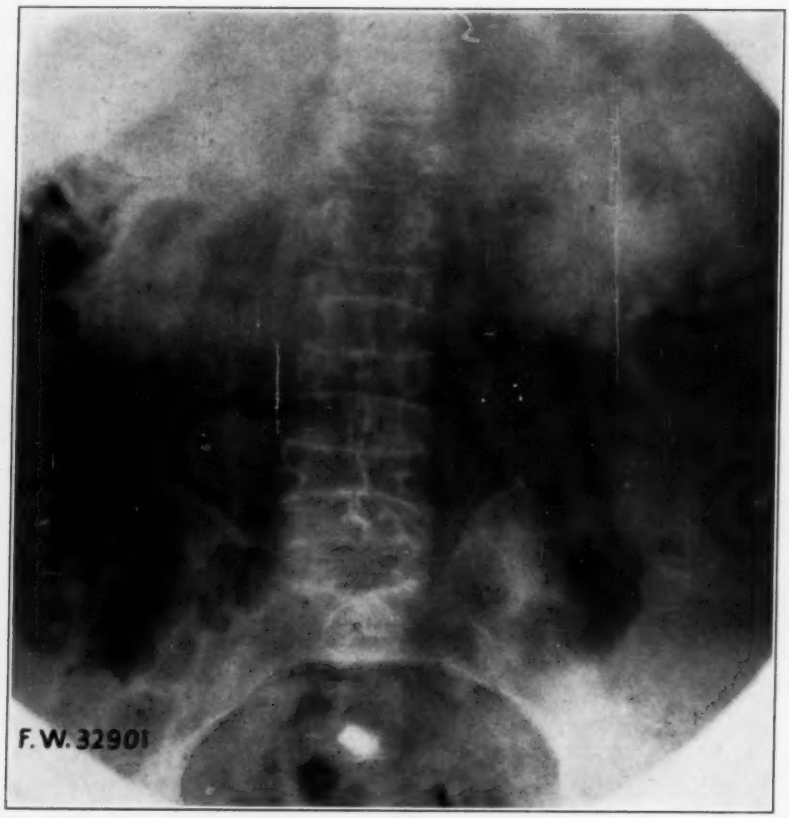

FIG. 10
Anteroposterior view of lumbar spine of Case 5.

In connection with these cases, it seems significant that their Case 3 showed evidence of metastasis to the spine fifteen months after onset of the primary tumor; whereas, in their Case 2, this period of time was two months,—that is, though there was a release of pressure in both cases by destruction of the vertebral body, in their Case 3 alone was the process so gradual as to admit of compensatory hypertrophy.

Third: The photomicrographs Figures 15 and 16 show evidence of the extension of the reparative processes healing the fracture of the cartilaginous layer to be from without inward, which would seem unlikely were there a force acting in a centrifugal direction, as implied by the theory of the elasticity of the nucleus. Weigert's elastic tissue stain failed to reveal elastic fibrils in either section.

Fourth: Photomicrographs (Figs. 18 and 19) show that there is an increased density of the tissue in the case of the pathological specimen as contrasted with the normal, with the occurrence of fibrocartilage.

Fifth: The calcium laid down in the spinal column in Case 5 (Fig. 11) under medication, was deposited exclusively in the discs. This would

FIG. 11

Lateral view of the lumbar spine of Case 5 taken after the administration of medication, showing calcification of the intervertebral discs and loss of the calcium content of the bodies.

FIG. 12

Lateral view of the dorsolumbar region of Case 5, showing compression fractures of vertebral bodies.

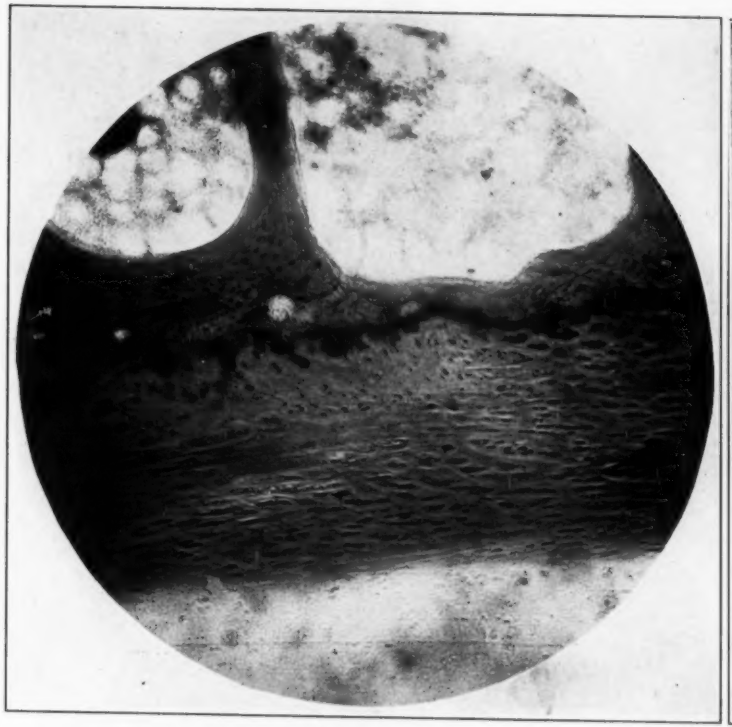

FIG. 13

View showing structure of cartilaginous layer of normal disc.

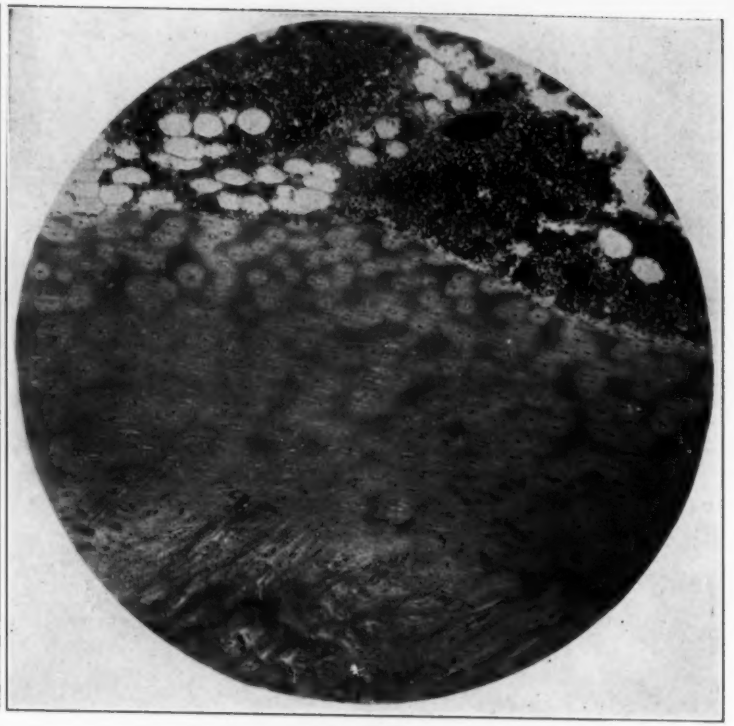

FIG. 14

View similar to Fig. 13 in pathological specimen, showing hypertrophy and change of character of cartilage cells. The fibrous element of the disc shown beneath the cartilaginous layer is hyperplastic and much more compact than in the normal.

FIG. 15

Pathological specimen showing rupture of the cartilaginous layer with hemorrhage from without into the intervertebral disc. This represents the first stage of repair.

be more likely to occur in this type of tissue in a state of hyperplasia.

In conclusion, the writer believes that, whenever an increase in the height of the disc is encountered in an x-ray of the spine, it should be considered evidence of disturbance of some sort in the adjacent vertebral bodies and the character of this disturbance should be determined whenever possible to avoid further impairment of the integrity of the spinal column.

SUMMARY

Five cases of pathological fractures are outlined, in which the changes shown by x-ray were found to indicate the decalcification of the vertebral bodies and enlargement of the intervertebral discs.

This enlargement is believed to be due to a hypertrophy of the cellular elements of the discs, rather than to expansion of the nucleus pulposus.

The occurrence of these enlarged discs in an x-ray of a spine is indicative of impairment of the integrity of the spine.

Pathological fractures may occur in vertebral bodies without local disease, as the result of faulty metabolism.

Acknowledgment for invaluable aid is due Dr. John E. McWhorter of New York, pathologist, and Dr. William G. Herrman of Asbury Park, roentgenologist.

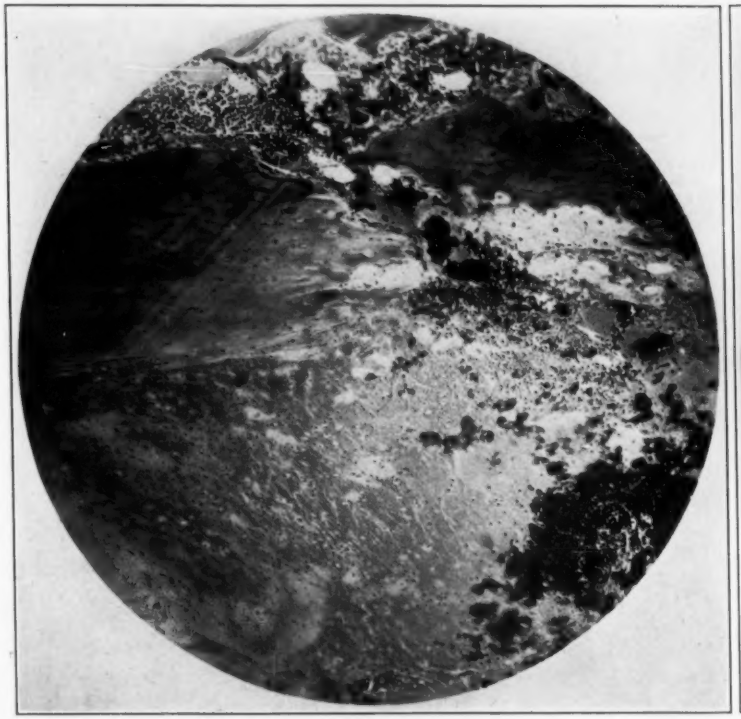

FIG. 16

Pathological specimen showing a more advanced stage of the reparative process with young granulation tissue.

FIG. 17

Pathological specimen showing further stage of the reparative process with scar tissue and some fibrocartilage.

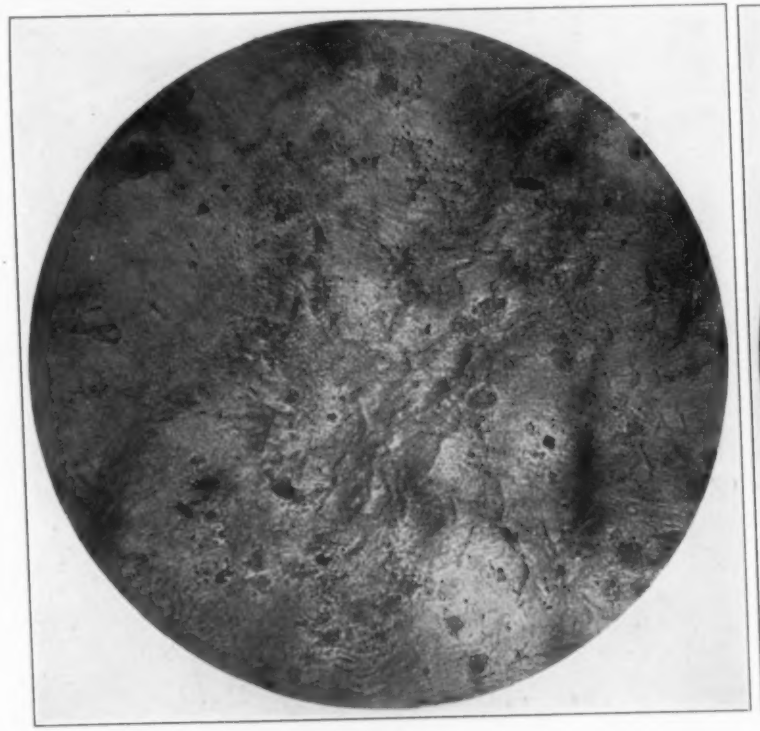

FIG. 18

Normal specimen. View showing structure of the interior of the disc. The fibrous tissue is not compact and contains many collagen fibers.

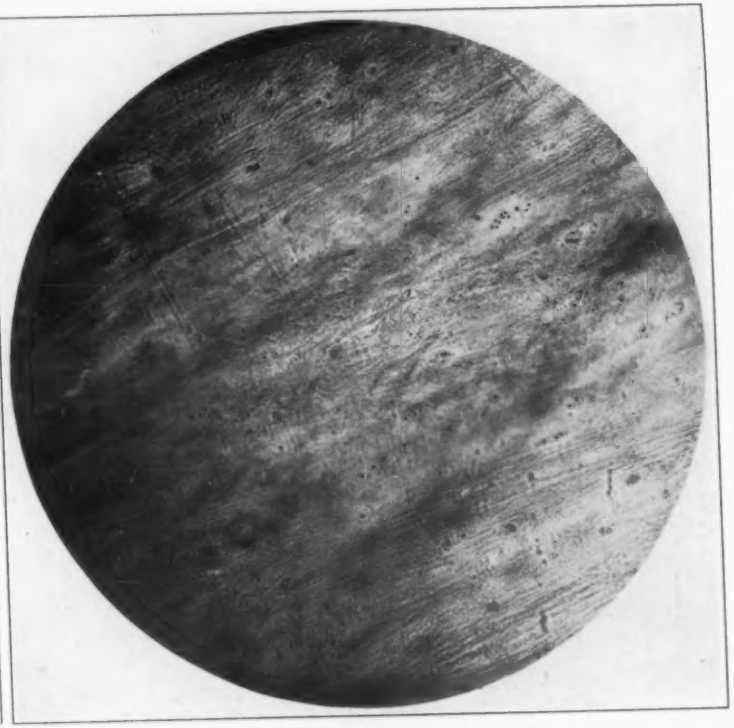

FIG. 19

Pathological specimen, view similar to Fig. 18, showing hyperplasia of fibrous tissue. The structure is much more compact and there are islands of fibrocartilage scattered throughout the section, indicating an attempt to strengthen the disc.

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CYSTS OF THE INTERNAL SEMILUNAR CARTILAGE

BY PAUL C. COLONNA, M.D., NEW YORK, N. Y.

From the Department of Orthopaedic Surgery, Bellevue Hospital, New York

Cysts of the semilunar cartilages are rarely reported and a review of the literature has disclosed only ten cases involving the internal (Table I) and about fifty involving the external cartilage.

A study of the pathological reports of cases shows the wide divergence of opinion that exists regarding their mode of production. The old German view was that these cysts were comparable to ganglia and arose as the result of a degenerative process from deficient nutrition following trauma. Ollerenshaw believes the cysts are embryologic in origin, developing from the preexisting spaces in the cartilages, but in general most of the other observers are inclined to the view that they are related to ganglion formation, the method of their production being a mucoid or myxomatous degeneration.

In this condition there is usually a history of previous trauma to the knee joint, though at times it may be quite difficult to determine its exact relationship. The patient walks with a limp, complaining usually of no acute pain but of a dull ache in the joint. There is rarely a history of locking. The knee sometimes reveals very little on inspection. Frequently there is a well defined sensitive mass seen over the cartilage affected, which becomes more prominent when the knee is semiflexed, but in the case here reported no mass was visible. The extremes of motion are usually restricted. The roentgenograms rarely reveal anything of significance.

The following case is reported:

A student, male, twenty-two years of age, weighing 180 pounds, was first seen on August 5, 1932. Previous to five years ago he had had no trouble with the knee whatsoever, but at that time, while playing football, he wrenched his left knee. He had to be carried from the field, and, according to his description, presented a perfectly characteristic clinical picture of a torn left internal semilunar cartilage. Under rest and support the knee gradually improved and he was able to continue playing football after a few months.

For the next four years and a half the knee gave him no pain, although it felt "weaker and less secure" than the right. In June 1932, six weeks before he was seen by me, he injured the knee and had a recurrence of his old trouble. Since that time there had been a sense of increased insecurity about the joint and he had had many attacks of very definite locking. These had been relieved by forcibly extending the knee, but he had had attacks of pain and stiffness three or four times a day.

Examination showed a well developed male, walking with a slight limp and holding the left knee slightly flexed. The knee joint was not enlarged and there were no visible masses noted. There was no sensitiveness on pressure over either the internal or external semilunar cartilages and no increased fluid. The movements were normal except in the extremes of motion. He was admitted to the hospital for an exploratory operation, the need for this based mainly on the history of frequent locking.

The operation was performed on August 10, 1932. Under an Esmarch bandage and general anaesthesia, the left knee joint was opened, using the medial patella incision. On opening the joint, a slight increase in the joint fluid was noted. On reflecting the patella laterally, it was immediately seen that the internal semilunar cartilage had been previously torn and the posterior portion was distorted and frayed. The anterior two-thirds was enlarged and thickened. Several small cystic areas, the largest being about one-eighth of an inch in diameter, yellowish in color due to their fluid contents, were

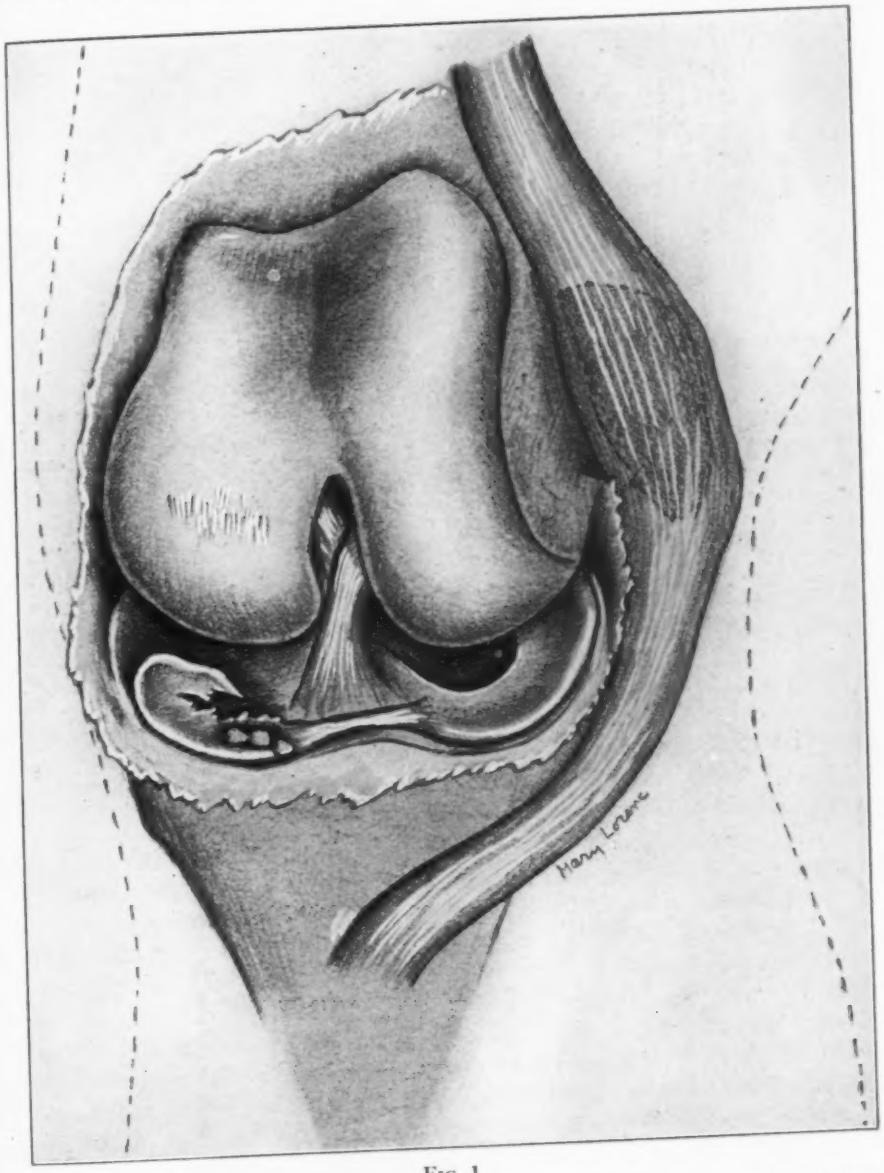

FIG. 1

Appearance of cartilages on opening joint. Note fibrillation of articulating surface of internal femoral condyle.

noted as shown in the drawing. There was a small area over the weight-bearing surface of the medial condyle of the femur which was fibrillated, but no definite erosion could be seen. The synovia was hypertrophied and purplish in color. The external cartilage appeared normal.

The internal cartilage was then completely removed. The wound was closed in layers and a pressure bandage applied from the groin to the ankle. The patient's convalescence was uneventful. At present he presents a full range of motion and has no pain on weight-bearing.

Through the courtesy of Dr. Douglas Symmers, Director, Division of Laboratories, Department of Hospitals, New York City, the pathological examination is here appended.

"*Macroscopic Examination:* The specimen consists of pearly white tissue measuring seven and five-tenths by three and seven-tenths centimeters. At one edge there are multilocular cysts, the contents of which are thin and watery.

"*Microscopic Examination* shows a groundwork of cartilage. The cartilage cells are irregularly scattered through the matrix, sometimes singly, at other times by twos and threes. The matrix itself is in places reticulated, in other places hyalinized, the hyalinization representing, apparently, direct transformation of the reticulated tissue. Numerous cyst-like formations are to be seen in the substance of the cartilage. The origin of this appears to take place in the following fashion: First, the cartilage breaks up into irregularly rounded or oval, isolated islands of hyalinized tissue, scattered through which only a few cartilage cells are to be made out. Various degrees of solution of cartilage can now be followed until the cartilage finally disappears entirely, leaving behind a cyst-like formation, the walls of which are composed of more or less well nucleated, reticular connective tissue which has arisen in an effort to wall off the autolyzing cartilage. In other words, the cysts or cyst-like formations come into being as a result of death of cartilage, the necrotic tissue acting as a foreign body which eventually is enclosed by connective tissue. The end result consists of complete solution and disappearance of the hyalinized and necrotic cartilage, leaving a cyst-like formation.

"*Histological Diagnosis:* Pseudocyst formation in fibrocartilage."

After the process of hyalinization has begun, the stages of cartilage death, liquefaction, and alteration of the connective-tissue cells into endothelial-like cells (lining these pseudocysts) by pressure from within are all logical sequences. We cannot agree with Fisher that these cysts are extracartilaginous in character or with Ollerenshaw that they are true endothelium with the power to secrete.

We believe they are degenerative in character, not arising from the lymphatics. The external cartilage is more firmly attached to the underlying tibial bone and is not, therefore, subject to the same degree of mobility during movement but, by its location on the outer side of the knee, is more frequently exposed to direct trauma. Whether this is a factor or not, the development of cysts in the external cartilage is much more frequently observed.

This is the eleventh reported case of cysts of the internal semilunar cartilage and here the picture was complicated by the case presenting an old torn semilunar cartilage, while in the anterior portion of the internal cartilage there were found definite multilocular cysts. These were located where they would necessarily receive very little of the trauma of weight-bearing and, except for the torn semilunar cartilage, the knee might not

FIG. 2

At left, two islands of hyalinized cartilage surrounded by and separated from one another by a layer of cellular connective tissue.

At right, pseudocyst formation, showing at the center an irregularly outlined remnant of hyalinized cartilage which is partly dissolved, and lined by a condensed layer of connective tissue.

Drawing made from slide with Edinger projection microscope (× 100).

have given evidence of their presence until they had increased in size. Certainly no clinical evidence of a tumor mass was noted. Therefore, this probably represents an early stage in this condition and would probably have been unrecognized except for the locking produced by the torn cartilage. The factor or factors that initiated the hyalinization of these cartilage cells remains a matter for speculation, though trauma cannot be overlooked. It is interesting in this connection to consider some experimental work done by McWhorter and his associates some years ago at Columbia University. They demonstrated that pseudocysts, presenting a cell wall of endothelial-like cells, could be experimentally produced by injecting into the subcutaneous tissues minute particles of sterile celloidin. These cysts resemble those found in the case here

TABLE I

SUMMARY OF CASES OF CYSTS OF THE INTERNAL SEMILUNAR CARTILAGE PREVIOUSLY REPORTED

Author	Date	Number	Sex	Age	Remarks
Fisher	1924	1 case	Male	27	Struck on inner side of knee by iron bar and definite lump noticed in six months.
Allison and O'Connor	1924	1 case	Male	22	No history of injury. Had noticed lump for three months.
Zadek and Jaffe	1927	1 case	Male	39	Wrenched knee several months previously.
Bristow	1928	2 cases	Male	69	No mention of injury. Aching pain in knee for four months.
			Male	55	No mention of injury. Lump noticed for six months.
Campbell and Mitchell	1929	1 case	Male	35	Painful knee five years. No history of injury.
Ollerenshaw	1929	4 cases	Male	10	Injured knee one year previously.
			Male	6	No history of injury.
			Male	23	Previously hurt knee playing football.
			Male	33	No injury. Disability for four months.

reported and it seems more logical to consider the cystic formations to be initiated by trauma. The deficient nutrition to the affected portion may cause the cartilage cells to be transformed into islands of hyalinized tissue, which become liquefied, and through the process of pressure these cyst-like spaces become distended and the altered tissue filling the spaces acts as a foreign body. The connective tissue is thereby flattened into cells that resemble endothelial cells.

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GIANT-CELL TUMOR OF THE SECOND CERVICAL VERTEBRA

A Case Report *

BY MERRILL K. LINDSAY, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT

Associate Clinical Professor of Orthopaedic Surgery

AND EDWARD H. CROSBY, M.D., NEW HAVEN, CONNECTICUT

Instructor in Orthopaedic Surgery

Giant-cell tumor of the long bones is relatively frequent, but the occurrence of such a benign tumor in the spinous process of the second cervical vertebra is unusual and, together with the age of the patient, makes the following case worthy of being recorded in the literature.

Dean Lewis [1] in 1924 reviewed the literature on giant-cell tumors of the vertebral column and found sixteen cases which, with the case reported by him, made the total seventeen. In his series the youngest was seven years of age and the oldest forty. The lesion occurred once in the cervical spine, six times in the dorsal spine, seven times in the lumbar spine, and once in the sacrum. The location was not mentioned in the remaining cases. Metastases were not found in any of these cases but recurrences were noted in two, four, and six years after operation. Ossification occurred in three of these growths. In none was an attempt at complete removal made, either because of the possibility of injuring the cord or because of the extension of the growth into inaccessible parts. Atoxyl, Coley's toxin, roentgen ray, and radium were used in treatment. Recovery after partial removal or no attempt at removal was noted in thirteen of the seventeen cases.

Geschickter and Copeland [2] in 1931, in their chapter on Benign Giant Cell Tumor, reviewed two hundred and fourteen cases of these tumors. None was found in the cervical spine and relatively few occurred in the dorsal and lumbar spine.

A. B. (A-17646), a six-year-old boy, of Irish birth, came to the New Haven Dispensary July 27, 1932, complaining of stiffness and swelling in the back of the neck. This swelling was first noticed two and one-half months previously as a symmetrical fullness which gradually increased in size. At the time of his examination, the boy held his head stiffly, slightly forward, but complained of no discomfort in the neck. He played with other boys normally and the stiffness of his neck in no way interfered with his activities. Past and family histories were without interest.

Physical examination showed a fairly well developed and well nourished boy in good health except for the local condition in his neck. The head was held forward with the neck flexed about twenty degrees and the lateral motion was limited to forty-five degrees to either side. The head could be fully flexed on the chest, but backward movement of the head on the neck was very markedly limited. Forceful attempts to move the head to the side and backward caused only slight discomfort. About two centimeters below the occipital protuberance and extending on either side of the mid-line was a sym-

* From Yale University, Department of Surgery, New Haven, Connecticut.

FIG. 1

Roentgenogram showing the giant-cell tumor of the second cervical vertebra.

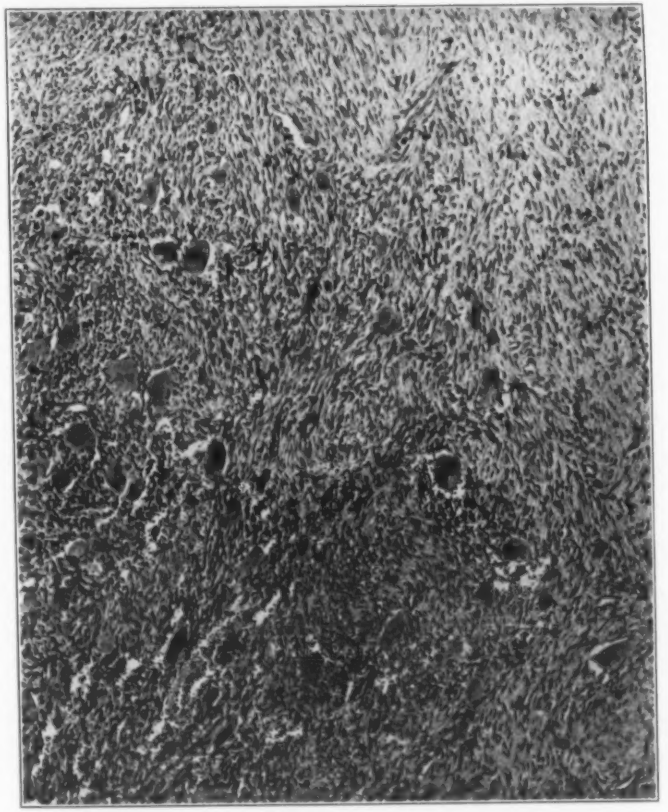

FIG. 2

Photomicrograph showing the typical arrangement of the fibrous connective tissue and the giant cells.

metrical, hard, smooth swelling, the size of a tennis ball. This tumor was immovable and beneath the superficial muscles. When the head was flexed forward on the neck, no movement could be felt in the tumor which appeared to be closely associated with the spinous process of the second cervical vertebra. Pressure over this tumor caused no discomfort and no irregularities could be felt. Careful examination of the nose and throat revealed no swelling in the posterior pharynx, and in all other respects the physical examination showed normal findings. The blood and urine were normal.

A roentgenographic examination (Fig. 1) of the cervical spine revealed the vertebral bodies and the interspaces to be within normal limits. There was an expansile, cystic tumor involving the spinous and the transverse processes of the second cervical vertebra. The cortex was thin and coarse trabeculations were seen within this mass. The mass measured approximately four by four centimeters in the two greatest presenting diameters.

The patient was admitted to the New Haven Hospital on August 30, 1932, with a preoperative diagnosis of giant-cell tumor of the spinous process of the second cervical vertebra. Under ether anaesthesia, a mid-line incision was made, extending from the occipital protuberance to the fourth cervical spinous process. Dissection was made downward and the tumor mass was encountered about one centimeter beneath the skin. The shell of this tumor was very thin, friable, and the calcified layer was barely perceptible. Considerable hemorrhage was encountered when the tumor tissue was cut. Bleeding was controlled by hot wet packs. Inside the tumor shell multiple loculations filled with blood and soft, grayish, friable tissue were encountered. The trabeculations were broken down with the finger, and the contents removed, but no attempt was made to completely excise the tumor. The spinal cord could not be seen or felt, and it was believed advisable to remove only the soft tissue of the tumor. The patient was placed in a posterior plaster shell and the postoperative recovery was uneventful.

The specimen removed at operation consisted of two pieces of tissue, measuring twenty by twenty by twelve and twenty by ten by five millimeters respectively, and also some smaller fragments. The larger pieces were firm and had irregular, gray-white, and in places, hemorrhagic surfaces. The fragments consisted of hemorrhagic osseous débris.

Microscopic preparations (Fig. 2) show that the tumor consisted of neoplastic fibrous connective tissue with the cell nuclei and fibers arranged in stream lines and whorls. Giant cells are scattered throughout the microscopic fields in a rather uneven distribution. In occasional areas they are missing; in others, where small bony trabeculae are present, they are more numerous. In the margin a fragment of osseous tissue is seen. The marrow spaces of this are filled mostly with a loose fibrous connective tissue with an occasional giant cell.

The patient was kept in the posterior plaster shell for twenty-six days and then allowed to sit up with a Thomas collar to support the neck. He was discharged from the hospital October 15, 1932. At the time of discharge, the patient was able to hold his head erect without support, the tumor was slightly smaller than on admission, and motion backward and to the sides was greater. Roentgenographic examination showed no apparent change in the size of the tumor, but there was slight thickening of the cortex posteriorly and some osseous proliferation on the inferior portion of the tumor.

SUMMARY

A case of giant-cell tumor of the spinous process of the second cervical vertebra is reviewed. A roentgenogram of this tumor is presented (Fig. 1), and a photomicrograph (Fig. 2) showing the typical arrangement of the fibrous connective tissue and the giant cells is included.

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TENDON AND MUSCLE RUPTURES

Clinical and Experimental Studies on the Causes and Location of Subcutaneous Ruptures

BY PAUL E. MCMASTER, M.D., CHICAGO, ILLINOIS

From the Department of Surgery of the University of Chicago

Following a report by the writer of late spontaneous ruptures of the extensor and flexor pollicis longus tendons subsequent to Colles' fracture, the subject of rupture of tendons has been further studied both clinically and experimentally. Results of these studies, including muscle rupture, are presented.

Subcutaneous tendon rupture occurs following direct and indirect types of trauma. Direct trauma, such as a tendon being caught between bone and traumatizing agent, may occasionally cause subcutaneous tendon rupture. The most common cause, however, is indirect violence, such as a forcefully contracting tendon subjected to a strong passive force in the opposite direction. Evidence will be produced to show that in this latter group true rupture of normal tendon does not occur.

Spontaneous tendon rupture, however, may follow moderate or frequently slight strain to a tendon previously weakened by disease, trauma, or possibly aseptic necrosis resulting from an obstruction to the blood supply.

Tendon rupture, either immediate or delayed, may follow severe direct external injuries to tendon substance. This division of tendon ruptures, also the direct severance of tendons by knives, glass, and similar articles, will not be stressed in this paper as these conditions do not give a true indication of the tensile strength of tendons.

However, in the indirect type of trauma the force is exerted along the entire muscle-tendon unit from origin to insertion and the strength of the different parts is put to test. It is with this division of the subject that this work is mostly concerned.

There are numerous clinical examples of "tendon rupture" following indirect trauma. One of the most frequent of these is the rupture at the insertion of the extensor tendons of the fingers into the base of the distal phalanges. This usually occurs following a forceful passive flexion of the distal phalanx, while the finger is being actively extended. It is not infrequently seen on the baseball field from a blow on the finger tip by a ball. The condition is often referred to as a "baseball finger" or "mallet finger". At the distal interphalangeal joint, capsule and extensor tendon are intimately associated. Hence, with this injury there is a separation of the tendon from its insertion and usually a capsular tear. Occasionally the tendon takes away a small fragment of periosteum and bone. There

is variance of opinion among surgeons as to the treatment of this condition. A number advise immediate operation with suture of the tendon to its point of insertion, followed by splinting in extension or hyperextension. Others, however, prefer conservative treatment and apply hyperextension splints immediately. This latter procedure has been the more successful one in the cases treated by the surgical staff of the University of Chicago Clinics. Hyperextension splinting is applied for four weeks. The end results in cases treated immediately by operation have often been discouraging. Stitches have either pulled out or infection has followed. and the deformity has sometimes recurred. In cases with the typical deformity, seen four weeks or longer after injury, operative repair is advisable, as otherwise the result will usually be unsatisfactory. In case the tendon heals in a lengthened condition, due to bridging the gap with regenerated tendon, a tendon shortening operation may be done.

Another tendon rupture occurring in the hands, although not frequently, is the rupture of the dorsal aponeurotic slip at the proximal interphalangeal joint. A brief review of the anatomy of the extensor tendons to the fingers will assist in an understanding of the mechanics concerned in these "button-hole" ruptures.

As the extensor tendons to the fingers reach the proximal phalanx, they spread out into three parts, a central tendon slip and two lateral slips. The central slip of tendon passes directly over the dorsal surface of this phalanx, becomes associated with the capsule of the proximal interphalangeal joint, and inserts into the base of the middle phalanx. The two lateral slips pass to either side of the interphalangeal joint, being loosely attached to the joint capsule, converge over the middle phalanx, and then insert into the capsule and base of the distal phalanx. Into these lateral slips of extensor tendons, the lumbrical and interosseus

FIG. 1

Photograph and roentgenogram showing the typical deformity of "button-hole" rupture. The proximal phalanx is extended, the middle phalanx is flexed, and the distal phalanx is hyperextended. The x-ray reveals a small fragment of bone almost completely detached from the base of the middle phalanx, at the insertion of the central tendon slip of the extensor tendon to the finger.

muscles are inserted. In the condition of "button-hole" rupture, the central dorsal slip ruptures and the two lateral slips, being loosened from their attachment about the joint, become displaced volarward. The volar displacement of these two tendon slips is further increased by the pull of the lumbrical and interosseus muscles. The cause of the injury is most commonly direct violence over the first interphalangeal joint; less commonly, as M. L. Mason[1] has pointed out, the fingers are being actively extended when a blow or fall leads to forceful passive flexion of the finger. The rupture in these cases is usually at the insertion of the central tendon slip into the base of the middle phalanx. Figure 1 illustrates such a case.

FIG. 2

The third, fourth, and fifth fingers have "button-hole" ruptures of the extensor tendons. On active extension of these fingers the same relations between the three phalanges were maintained,—namely, extension of the proximal phalanx, marked flexion of the middle phalanx and hyperextension of the distal phalanx, as shown in this illustration. The condition in the fifth finger was less marked than in the other two although the deformity is present on extension of the finger.

This woman, aged thirty-seven, caught her right hand in a washing-machine wringer one month before coming to the University of Chicago Clinics. Following the injury the patient was unable to fully extend or flex the right third finger. Examination revealed considerable swelling about the proximal interphalangeal joint. On attempting to extend the finger, the typical deformity,—namely, hyperextension of the distal phalanx, flexion of the middle phalanx, and extension of the proximal phalanx, resulted. Roentgenograms showed a small bony fragment almost completely detached from the base of the middle phalanx at the point of insertion of the central tendon slip. Operative treatment was advised but has been refused. Subsequently operation was performed and the findings were similar to those described in the second case. The deformity has been improved and function is good.

A second case illustrating this condition was as follows:

A woman, aged twenty-seven, had had her right hand caught in a door jamb eighteen months prior to admission. Following the injury the right third, fourth, and fifth fingers became "drawn up" as she described it. On examination these three fingers exhibited the typical deformity of "button-hole" rupture, that of the fourth finger being the most marked (Fig. 2). Roentgenograms revealed no bone pathology of the proximal interphalangeal joints. Due to the long standing of this condition it was decided to operate upon one finger at a time. The fourth finger, being the worst, was chosen first. At operation the two lateral slips of tendon were found displaced volarward, the medial slip being displaced considerably more than the lateral. After freeing these slips from a number of adhesions and on attempting to straighten the finger, the flexor tendon was found to be preventing complete extension. However, after exerting considerable passive force, the finger was extended and it was then noted that the rupture of the central tendon slip had healed in a lengthened condition. This portion was shortened and the

two lateral slips were then sutured together with linen over the proximal interphalangeal joint. After closure the finger was placed in a hyperextension splint. Infection and sloughing out of sutures gave a poor result in this case.

Rupture of the supraspinatous tendon has been studied extensively by Codman and Akerson [2, 3]. It is significant that this condition occurs practically always in middle-aged or older people. Hence as Codman says there may be changes in the integrity of the tendon due to age, constitutional conditions, or overuse. Wilson[4], who has also studied this condition in a number of patients, states that the pathological observations at operation indicate gradual weakening of the tendon previous to the occurrence of rupture. Doubtlessly repeated trauma, as forceful sudden abduction with the tendon caught between the greater tuberosity and the acromion process, accounts for damage to this tendon. Following such an injury the fairly common sequel of calcification may result, and, subsequent to this condition, rupture could occur. Codman further states that the rupture may be the result of the same phenomenon which is known as arthritis in other joints. He also considers attrition of the tendon as an etiological factor to this rupture.

FIG. 3

Bilateral rupture of the long head of the biceps brachii. The ruptures occurred within a few days of each other and followed only slight exertion. This patient had generalized hypertrophic arthritis.

In considering rupture of the long head of the biceps brachii, there is considerable doubt if this occurs in the tendon substance without some preexisting disease which weakens it. Meyer [5, 6] has made numerous anatomical studies of shoulders and has a number of times found the tendon of the long head of the biceps destroyed. The destruction with rupture occurs in the region between the humeral tuberosities and the supraglenoid tubercle of the scapula. From his studies he postulates that the destruction of the tendon is due to an occupational trauma and considers abduction and external rotation the motions responsible. Hence his explanation for this rupture is on a basis of friction. Cotton [7] states that rupture of the long head of the biceps is due to fraying of the tendons as a result of an occupational arthritis. Gilcreest [8] believes that senility, with degenerative changes, or disease are important etiological factors. Steinmann [9] reviewed this subject, including the report of the German industrial surgeons in 1931. He states that rupture of the long head of the biceps brachii is a result of chronic damage to the tendon.

Figure 3 shows a patient with bilateral rupture of the long head of the biceps brachii.

This patient, sixty-five years old, had a generalized chronic arthritis. The ruptures occurred within a short time of each other and both followed only slight muscular exertion. These ruptures probably occurred as a result of fraying of the tendons from arthritic changes in the shoulder joints. The condition resulted in but slight weakness and discomfort and was left untreated.

Gilcreest [8] reports an interesting case of avulsion of the long head of the biceps from its origin, including a portion of the cartilage of the glenoid attachment, following an indirect type of violence. Hence, in this case with the tendon normal, separation occurred at the origin and not in tendon fibers. Gilcreest quoted Dr. Wilson Davidson as telling of a baseball pitcher who, on releasing a ball, felt a "snap" in his arm. On examination there was found a rupture of the triceps at the junction of the muscle and tendon rather than in the tendon itself.

A case reported by Schmieden [10] and another by Kerschner [11] further demonstrate the strength of tendon substance. In each there was detachment of the biceps tendon from the radial tuberosity. Here again the tendon itself did not rupture but the insertion gave way. Schmieden stressed the fact that rupture of the long head of the biceps follows a pathological change in the tendon fibers.

Another spontaneous tendon rupture encountered in the upper extremity occurs in the extensor pollicis longus and in all of these cases there is a preexisting tendon disease or injury. The most common cause of this rupture is a chronic tenosynovitis, occurring in drummers and first described by the Germans as "*Trommlerlähmung*", or drummers' paralysis. The condition occurs in other occupations also, such as tailoring, carpentering, and cane-making. The tenosynovitis occurs at the distal border of the radial groove, where the tendon runs obliquely laterally around the bony ridge of the radial groove. Degenerative changes occur, consisting of swelling, inflammation, and aseptic necrosis. These may lead to tendon rupture following some exertion.

Rupture of this tendon also occurs as a late spontaneous sequel of Colles' fracture. It is due either to a partial tendon severance by a sharp bony fragment at the time of fracture, with insufficient healing and subsequent rupture at the weakened point following exertion (occasionally only slight), or to a local tendon necrosis resulting from injury to its blood supply at the time of fracture. The added pressure of the hematoma or later the callus may further obstruct the blood supply. A similar case has also been reported of late spontaneous rupture of the flexor pollicis longus tendon following Colles' fracture (McMaster [12]).

Tendon ruptures in the lower extremity are not infrequently encountered,—*e.g.*, in the Achilles tendon, quadriceps tendon, ligamentum patellae, and adductor tendons of the thigh. A rare tendon lesion which would predispose to rupture was reported by Meyer [13] who found in a cadaver a marked fraying of the peroneus brevis at the point of the calcaneofibular ligament.

Rupture of the Achilles tendon occurs, but it is problematical if it takes place in normal tendon substance. Quénu and Stoïanovitch [14] in 1929 reported two cases and collected sixty-eight others from the literature. They stated the condition to be rare, not encountered in the young or old, and most common between the ages of thirty and fifty. It was especially common in large and fat people, although occasionally found in those of athletic build. The authors explained these ruptures on the basis of some particular weakness of the tendon and considered syphilis important. In reviewing the cases from the literature, they found that the majority occurred in syphilitics and a number demonstrated the presence of gummatous invasion in the ruptured tendons. The presence of such a condition explained why some of the tendons ruptured from only slight force. König [15] stated that these ruptures are usually associated with some disease,—as peritendinitis, lues, typhus, scarlet fever, and tabes. König also records a bilateral rupture of both Achilles tendons in a young adult male who sometime previously had been an athlete, but, because of a bad heart lesion, was then having very little exercise. Following a sudden strain, both Achilles tendons separated. Associated with these ruptures there was also a bilateral tearing out of a small bony fragment from each tendon insertion.*

True rupture of the ligamentum patellae and quadriceps femoris tendons occurs rarely if ever. Most often, following indirect trauma, either the patella fractures or the insertions of these tendons to it give way (Hugel [16]), or the quadriceps tendon pulls away from its muscle junction. In not a few cases there is a small fragment of bone pulled away, especially with rupture of the quadriceps femoris tendon (R. L. Mason [17]). Gallie and Le Mesurier [18] described a number of cases of the above nature, including fractured patellae, but reported no cases of separation in the tendon substance itself. Wagner [19] reported a complete rupture of the infrapatellar tendon and adjacent capsular ligaments, which, although not clearly stated, apparently was a tearing out of the tendon at its insertion. R. L. Mason [20] has described a case of complete avulsion of the tibial tubercle and, according to him, Wilson found only two such cases in a review of the records of the Massachusetts General Hospital Fracture Service. Partial separation of the tibial tubercle, sometimes seen in Osgood-Schlatter's disease, is not infrequent.

Cotton [7] mentions the rare possibility of ruptures through the patellar ligament and through the quadriceps tendon. In a review of the available literature, I have not found a case that I think should come under this classification.

Fracture of the anterior superior spine of the ilium has been reviewed by Christopher [21]. In this condition, which practically always occurs before the epiphyses are closed, a small fragment of bone is detached from

*Since this paper was written the author has encountered two cases of rupture of the Achilles tendon at the University of Chicago Clinics. One was at the insertion and pulled away a bony fragment; the other occurred at the musculotendinous junction.

the anterior superior spine of the ilium, by indirect violence of the tensor fasciae latae and sartorius muscles. A more appropriate designation, instead of fracture, is avulsion of the anterior superior spine. Rupture does not occur in the tendinous portions, but a small bony tag is pulled away from the origin, indicating a greater weakness of bone.

Davidson [22] reported two interesting cases of rupture of the adductor longus and adductor brevis muscles. Both of these had pulled out at their insertions in the femur and not in tendinous substance.

Among other pathological conditions predisposing to tendon rupture are tuberculous tenosynovitis (Kanavel [23]) and gonorrhoeal tenovaginitis (Melchior [24]). A number of the former cases are found in the literature, but only one case of the latter, that reported by Melchior.

Destruction of tendon by tuberculosis is illustrated in the following case:

White male, aged twenty, had an arthrodesis for tuberculosis of the left ankle, one year previous to his second admission to the Clinics. At this admission a painful right shoulder was diagnosed as tuberculous arthritis. At operation for arthrodesis of the shoulder, extensive tuberculosis of the glenoid and head of the humerus was found. The intra-articular portion of the long head of the biceps was completely destroyed. The tendon and its sheath in the bicipital groove were extensively involved, the sheath having ruptured about two inches below the tubercles anteriorly, with caseating granulation tissue extending into the surrounding soft parts. Arthrodesis of the shoulder by bone transplantation was done. The long head of the biceps was excised down to healthy tendon which was then sutured to the short head. A cast was worn for four months. Six months after operation the shoulder was solidly fused and the biceps, although small, functioned as a whole.

Suppurative tenosynovitis frequently destroys tendons; however it rarely leaves a damaged tendon that subsequently ruptures.

MUSCLE RUPTURE

Rupture of muscle, either complete or incomplete, is a fairly frequent occurrence. It may be by direct or indirect violence, and occur either in normal or diseased muscle.

Undoubtedly if many of the aching and painful muscles, resulting from trauma, either direct or indirect, could be examined anatomically, a considerable number of partial muscle ruptures would be found, which are often overlooked or wrongly diagnosed as sprains, hematomata, myositis, neuralgia, etc.

The following four cases are examples:

Case 1. Large obese female of thirty-nine, while running, caught her foot in a carpet and a few steps later fell because of severe pain in the calf of the left leg. The pain at first extended from her heel to the knee, but soon localized in the mid-calf region. Examination showed extreme tenderness over the mid-point of the left gastrocnemius muscle and the patient was unable to bear weight upon the foot. There was slight swelling, no discoloration of the skin and no muscle defect could be found. A diagnosis of partial rupture of the muscle belly of the gastrocnemius was made. Treatment consisted of an elastic bandage to the leg, and rest. After approximately three weeks all pain disappeared and full painless motion was present.

CASE 2. Well developed male of forty-eight, while pushing a heavy cart with an 1800-pound load, received a sudden unexpected strain on his arms. He felt something "give way" in the right neck and shoulder region with resultant pain. Disability was only slight, but pain persisted. Examination was essentially negative, except for pain to palpation in the muscle belly of the right trapezius. Swelling and discoloration were not present. Active and passive motions of the shoulder caused very slight pain. Diagnosis of partial rupture of the right trapezius muscle was made. After treatment for two weeks with the shoulder immobilized in a sling combined with heat and massage, the patient had completely recovered.

CASE 3. White male, aged thirty, received a severe direct injury from a heavy iron pulley to the right forearm twelve months before admission to the Clinic. A few days prior to his admission he attempted, for the first time after the accident, to do heavy lifting. He suddenly experienced great pain at the point of his previous injury. Swelling, discoloration, and weakness resulted. At operation a nearly complete fresh rupture of the flexor carpi radialis muscle was found. At the site of rupture there was considerable scar tissue, indicating a partial muscle belly rupture following the original direct injury.

CASE 4. Two powerful men, sitting opposite each other, rested right elbows on a narrow table, with the forearms upright, grasped hands, and each attempted to bend the other's forearm down to the table. After twenty minutes with neither succeeding, one suddenly developed a severe pain in the belly of the biceps muscle. This was followed by considerable swelling and some discoloration. Severe pain to palpation was present in the muscle belly. No defect was palpable, due to the swelling. Some biceps motion was present, but definitely limited. This case illustrates muscle belly rupture from severe indirect violence.

Muscles rupture in the contracted state when incurred by indirect violence. Lexer[25] states that a muscle may be ruptured in the resting state by indirect violence, but this seems very unlikely, at least in normal muscle.

FIG. 4

Almost complete rupture of the rectus femoris muscle belly by direct violence. The mass shown above the depression in the mid-thigh on the anterior surface was easily seen when the quadriceps femoris was contracted.

Direct injuries may also cause muscle rupture, but, according to Lexer, this is rare when compared to indirect violence with rupture of the contracted muscle. Montgomery [26] reported a case of ruptured triceps muscle belly, following a severe direct blow on the muscle.

The following case illustrates muscle rupture from direct injury:

Male, aged thirty-two, received a direct blow on the left thigh and ankle with a heavy piece of steel three months before admission to the Clinics. A fractured left ankle had been treated by a cast for eight weeks. Considerable swelling and soreness occurred in the left thigh immediately following the injury. This gradually subsided, except for slight weakness and a noticeable painless mass on the anterior surface of the lower third of the thigh. The mass stood out prominently when the leg was extended (Fig. 4). At operation a nearly complete rupture of the left rectus femoris muscle at its junction with the quadriceps tendon was found. The muscle was pulled down and sutured in its normal position. Contour and function were restored to normal.

Another patient, female, aged twenty-two, was operated on in the Clinics for almost complete rupture of the rectus femoris muscle belly, following direct trauma from an auto accident (Fig. 5). Nearly normal function and appearance have returned.

Disease processes may be etiological factors in muscle rupture. During the "flu" epidemic in 1918–1919, Abrahams *et al.*[27] saw over twenty cases of ruptured rectus abdominis muscles associated with pneumococcal and streptococcal influenzal septicaemia. The location was below the level of the umbilicus. The muscles examined at autopsy by these authors showed a definite relationship to Zenker's degeneration, such as occurs in other infectious maladies, except that these muscles were hemorrhagic and not pallid.

FIG. 5

Almost complete rupture of the rectus femoris muscle belly from direct trauma.

TABLE I

RUPTURES IN NORMAL GASTROCNEMIUS TENDON-MUSCLE-BONE PREPARATION

	Approximate Weight Producing Rupture (kilograms)	*Location of Separation*
1	23	At insertion and with small bony fragment from os calcis
2	17	From medial femoral origin with bony tag
3	20.5	Femur fractured through point of drill hole
4	18.4	Same as 3
5	16	Same as 1
6	21.2	Musculotendinous junction
7	20	Both femoral origins with small bony tags
8	16	Insertion with bony cap attached
9	10.4	In muscle belly

Culbertson [28] and Perman [29] have reported rupture of the rectus abdominis during pregnancy and called attention to the susceptibility of this muscle, weakened by pregnancy, to subsequent spontaneous rupture.

Gilcreest [8] thinks that muscles rupture following certain occupational efforts,—*e.g.*, rupture of neck muscles occurring in load carriers and packers; of the biceps and triceps in pitchers and lifters; of the adductors of the thigh in horseback riders; of the calf muscles in boxers, tennis players, runners, and mountain climbers; and of the back muscles in stevedores.

Other pathological conditions of muscles which may lead to rupture are tuberculosis, syphilis, tumors, trichiniasis, typhoid, and general infections. Tetanic convulsions may also cause muscle rupture.

EXPERIMENTAL WORK

In order to determine the tensile strength of tendon fibers and the points of rupture, a series of experiments was done. These included tests on normal tendons, crushed tendons, tendons partly severed, tendons completely severed and sutured, and tendons ligated in an effort to obstruct the blood supply and produce aseptic necrosis. Young, healthy adult rabbits were used, and aseptic technique was employed where operative procedures were done.

In all experiments the rabbits were sacrificed and immediately the following procedure was carried out. The skin was dissected free from the leg which was then amputated through the upper thigh. The os calcis was separated from adjacent bones, with the Achilles tendon attached, and the gastrocnemius muscle more or less freed from surrounding tissues and left attached to the femur. A small drill hole was then made through the lower portion of the femur and a strong wire passed through. This was suspended from an overhead beam. Then to the os calcis was attached another wire from which hung a bucket and into this sand was added for weight (Fig. 6*a*).

In some of the experiments the sand was slowly poured into the bucket giving a gradually increasing weight until separation occurred.

In others a sufficiently heavy load to produce rupture was suddenly added. As to the type or location of the rupture, no difference was noted in the two procedures.

EXPERIMENTAL RESULTS

Nine normal preparations were used to determine the point or different points of rupture in tendons not previously diseased or injured. The exact amount of weight to produce these separations was not accurately determined, but approximate weights are included (Table I).

Ascertaining from these experiments that normal tendon did not rupture, tests were made to determine how much injury the tendon of such a preparation must sustain before it would break.

The same procedure as outlined above was carried out on tendons cut one-fourth through, just prior to testing with the weight. In three experiments the tendon did not rupture at the injured point. One separation occurred in the muscle belly, another at the periosteal insertion, and in the third the femur fractured.

Three tendons were then cut one-half through, just prior to adding the weight. All three ruptured at the point of partial severance.

Two tendons were severely traumatized by crushing with a Kocher hemostat and then tested. Rupture did not occur in either case at the crushed portion but occurred once in the muscle belly and once at the insertion.

A study of the effects of severe injury to tendon substance after allowing time for either tendon repair or necrosis was done as follows: Through a small incision the tendon was exposed, the sheath retracted, and the tendon traumatized by crushing with a Kocher hemostat and by pounding until fraying at this point resulted. The sheath was carefully replaced and sutured and the skin closed. In two experiments tested two weeks later, rupture occurred in the muscle belly instead of in the injured portions. Five weeks after the same procedure, two tendons were tested and rupture occurred once in the muscle belly and once at the insertion, pulling off a small bony tag.

The same procedure as above was then done, excepting that a cuff of

TABLE II

EFFECT OF DOUBLY LIGATING ONE CENTIMETER OF THE TENDON AND SHEATH

	Time After Operation (*days*)	*Weight* (*kilograms*)	*Location of Separation*
1	10	14.8	Periosteal insertion
2	10	13.2	Femur fractured
3	14	15.4	Muscle belly
4	14	16.2	Muscle belly
5	21	22.4	Muscle belly
6	21	21.2	Muscle belly
7	35	13.2	Origin with bony fragments
8	35	10.2	Ligated portion
9	35	9.8	Ligated portion

tendon sheath, two and five-tenths centimeters long, was removed around the severely traumatized portion. Two such preparations, tested five weeks later, separated at their origin and in the muscle belly respectively. Two other tendons, including sheath tissues, were crushed and severely pounded. When tested five weeks later, rupture occurred both times in the muscle belly.

The effect on the tensile strength of ligations of the tendon and sheath at two points one centimeter apart, thereby interfering with the blood supply, was then studied. The tendons were isolated through a small incision and with the tendon sheaths were tightly ligated in two places about one centimeter apart with heavy black silk. The overlying tissues were then sutured. Results are shown in Table II.

Four tendons and sheaths were then exposed, as outlined before, and severely traumatized with a Kocher hemostat and by further pounding the tendon until fraying occurred. Since this single procedure had not led to rupture after five weeks, strong ligatures were placed around the tendon and sheath above and below the injured portions. Two of these tendons were tested after three weeks, but separation occurred in both preparations at the insertion, detaching a small bony fragment. The other two were tested after four to five weeks. One separated at the insertion, although some necrosis was present at the injured area. The second one, however, ruptured at the injured area.

Two other tendons were then exposed, the sheath being retracted and the tendons crushed and pounded as described before. The tendons only were ligated above and below the injured areas and the sheaths carefully replaced by suture. These were tested five weeks later; one ruptured at the injured portion and the other at the muscle origin from the bone.

One tendon was cut one-half through and the sheath carefully sutured. When tested five weeks later, rupture occurred at tendon insertion. Another tendon, operated on at the same time, was severed one-half through and then ligated above and below the cut, the sheath being replaced. When tested five weeks later, rupture occurred at the point of injury.

To further test tendon strength and the strength of repaired, previously injured tendons, the following procedures were done. The Achilles tendon was exposed through a small opening and severed approximately three-fourths through. Tendon sheath and overlying tissues were then replaced. In five experiments casts were applied to the leg and foot to obtain immobilization, while in three the limbs were left free. The rabbits were allowed to run loose in their cages. Spontaneous rupture did not occur following either procedure. The casts were removed from the five animals and the muscle-tendon preparations tested four to five weeks after operation. They all held solidly in the injured portion, with separation occurring twice at the insertion, twice in the muscle belly; and in the other, the femur fractured. The three tendons, which had been cut without subsequent immobilization, on gross examination showed

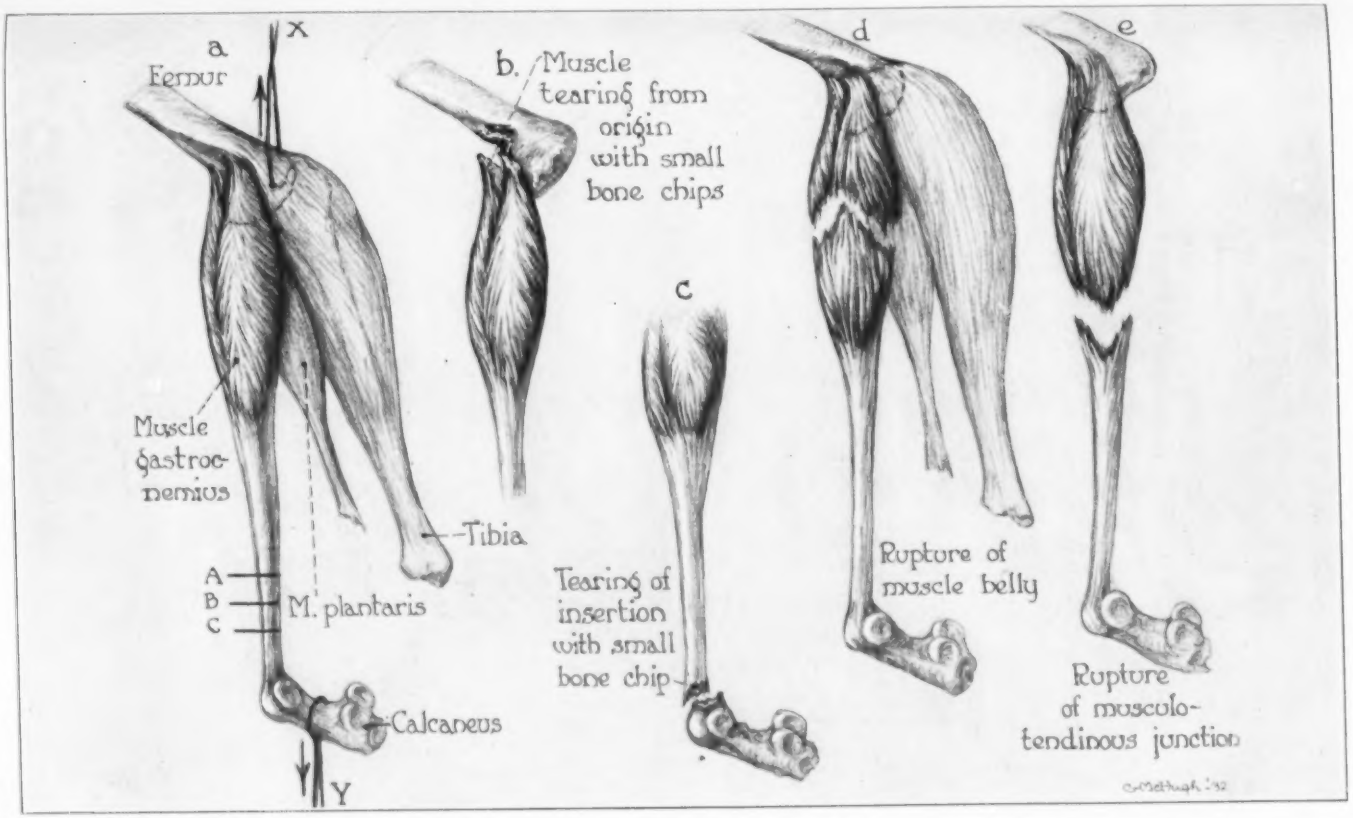

FIG. 6

Diagrammatic illustrations showing in *a* the muscle-tendon-bone preparation used to determine the point of separation. The wire *X* was suspended from an overhead beam. To wire *Y* was hung a bucket, into which weight was added. *B* illustrates where trauma and severance of tendon were done, and *A* and *C* where ligatures were placed, when these procedures were used. Drawings *b*, *c*, *d*, and *e* represent points of rupture in normal tendon and muscle (both clinically and experimentally) when subjected to indirect violence. It will be noted that normal tendon does not rupture.

evidence of separation of the cut portions; but spontaneous rupture of the cut portions had not occurred. When tested with weight three to four weeks after operation, they held solidly in the cut areas, separation occurring once at the tendon insertion, once in the muscle belly; and in the third, the femur fractured.

Completely severed Achilles tendons were then sutured. Strong ligatures of silk, one on each side of the suture line, were placed about the tendon. The sheath and skin were carefully sutured over the cut and casts applied to the legs. When examined four and five weeks later, necrosis at the ligated area had permitted wide separation of the tendon ends in two cases. In two others necrosis was present and the weak union was easily broken by hand. Two sutured tendons, which were not ligated and which were in legs to which casts had been applied, held solidly when weight was added five weeks later, rupture occurring once at the tendon insertion and once at the musculotendinous junction.

DISCUSSION

This type of experiment appeared to be the most satisfactory for testing the resistance, or tensile strength, of muscle and tendon. It does not offer an exact analogy to the conditions existing clinically; for in these experiments the animals were sacrificed and the muscle-tendon-bone preparation dissected free. However, the preparation was immediately wrapped in warm saline and tested so that no appreciable deterioration could have occurred. Another objection that might be made is that the skin and surrounding parts to the muscle, tendon, and bone had been removed. However, such a procedure allows a true test of the respective strength of the muscle, tendon, and bone in each preparation without other elements—such as skin and fascia—complicating the picture.

In a few of the tests it is noted that the femur broke before other parts gave way. This is somewhat objectionable as the femur was slightly weakened by the drill hole. However, the weights necessary to produce the fracture were often more than those required to cause rupture elsewhere in other specimens.

Whether weight was added either gradually or suddenly, there was no difference in the location of the rupture. In the former procedure, however, stretching occurred, which seemed to be largely in the muscle bundles and less in tendon fibers.

From these observations it is evident that normal tendon does not rupture. In fact a tendon must suffer considerable damage before it will rupture. Instead, the tendon insertion or muscle origin gives way, often detaching a small fragment of bone; or the muscle belly ruptures; or the musculotendinous junction separates (Fig. 6—*b*, *c*, *d*, *e*); or the bones fracture.

Wagner [30] briefly reviewed the subject of fractures (avulsion of bony fragments) by strong muscle contractions and added seven cases which included two of the spinous processes of the vertebrae, two of vertebral

transverse processes, two of the anterior superior spine of the ilium and one of the os calcis. This type of injury, which indicates a greater weakness of bone when compared to tendon and muscle, occurs most frequently before the epiphyses close. Adults, however, are not spared. In one of the cases reported by Wagner, the os calcis "fractured" during violent muscle contractions, while the male patient, aged thirty-four, was lying in bed. Honigsmann [31] mentions that subluxation or luxation of a joint occurs before rupture of a tendon. Among numerous clinical examples of the great tensile strength of tendon is one reported by Adams.[32] A seaman caught his right third and fourth finger tips in a door jamb. On jerking his hand away, he suffered a traumatic amputation at the distal interphalangeal joint of the third right finger and with it pulled away "fifteen inches" of the flexor profundus digitorum tendon and some muscle fibers. The rupture in this case occurred not in the tendon substance, but at the musculotendinous junction.

In these experiments approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to strain. Severing one-fourth of the fibers was not sufficient, nor was severe trauma from crushing and pounding. If, however, following any of the above injuries the blood supply to the involved part was obstructed, rupture occurred when test was made after four to five weeks.

On the other hand, when one-half of a tendon's fibers were severed, but with no obstruction to the blood supply, rupture did not occur when test was made after five weeks. Rupture did result after five weeks, if the blood supply had been obstructed.

Simple double ligation of a tendon, one centimeter apart, followed by suturing the tendon sheath, produced sufficient aseptic necrosis to cause rupture after five weeks when subjected to strain. The same was true when the sheath was ligated with the tendon. Obstruction to the blood supply of the tendon did not produce rupture before four to five weeks in these experiments.

Whereas severely traumatized tendons did not rupture four to five weeks later when tested with weight, it was interesting to note that, if the tendon was ligated on both sides of such an injury and the sheath sutured, rupture did occur in the injured area with strain. This presents evidence that the essential blood supply to a tendon, at least in rabbits, is carried in the tendon substance and not mainly in the sheath tissues. In fact severe injury to a tendon, as by crushing followed by stripping off the tendon sheath for two and five-tenths centimeters above and below the injured portion, did not cause rupture four to five weeks later, when tested with weight, if the tendon blood supply was unobstructed.

Microscopic examinations of the tendons with obstruction to the blood supply showed aseptic necrosis and absence of infection in the obstructed areas.

An example of assumed aseptic necrosis of tendon with subsequent rupture, resulting from obstructed blood supply (by fracture callus), is

illustrated in the case reported by Ashhurst.[33] Five weeks following a Colles' fracture, spontaneous rupture of the extensor pollicis longus tendon occurred after a grasping motion by the patient. At operation two weeks later, the proximal end of tendon was found densely adherent in fracture callus, but the distal end had pulled away and was frayed. No microscopic report was made.

Mason and Shearon [34] have recently called attention to the important rôle of both the tendon sheath and tendon in the repair of experimentally severed tendons followed by suture of the cut ends. The sheath, they stated, was more important than the tendon in the early bridging of the defect. After the fourth or fifth day the tendon proliferates and, if the gap is not too great, tendon cells bridge the defect in about two weeks. This union, however, broke when subjected to strain, as did similarly treated tendons between the fourth and fifth weeks postoperatively.

If conclusions applicable to clinical cases may be drawn from the results of the experiments in this paper, it is evident that in suturing tendons, either partly or completely severed, great care should be exercised, especially in placing sutures so that the blood supply to the tendon ends is not obstructed. It is not intended to minimize the possible importance of the sheath tissues in the repair of tendon injuries and the prevention of adhesions, but the apparent greater importance of viability of the tendon in reparative processes is emphasized.

SUMMARY OF EXPERIMENTS ON RABBITS

1. Normal tendon did not rupture when subjected to severe strain. Either the tendon insertion pulled away, or the muscle belly ruptured, or the musculotendinous junction separated, or the muscle origin pulled out, or fracture of the bones occurred. The tendon or muscle in pulling away from either insertion or origin, respectively, detached a small fragment of bone.

2. Approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to severe strain. Spontaneous rupture did not occur following severance of approximately three-fourths of a tendon's fibers under ordinary activity.

3. Obstruction to the blood supply of one centimeter of a normal tendon by double ligation caused rupture in this obstructed area as early as four weeks afterwards, when it was subjected to strain, even though the tendon sheath had been carefully replaced.

4. The blood supply of a tendon was more important in the reparative processes of injured tendons than the presence of the tendon sheath.

CONCLUSIONS FROM CLINICAL OBSERVATIONS

1. When a normal muscle-tendon system is subjected to severe strain, the tendon does not rupture. However, rupture may occur at the insertion of tendon to bone, at the musculotendinous junction, through the belly of the muscle, or at its origin from the bone. Either muscle or ten-

don may pull away a small fragment of bone. Sometimes the strain results in fracture or dislocation.

2. Disease processes in tendons predispose to their spontaneous rupture often from only slight strain.

3. Rupture of muscle fibers occurs following both direct and indirect types of trauma. Degenerative changes and disease processes in muscles predispose to their rupture.

4. Minimal to more extensive muscle ruptures occur following varying degrees of direct or indirect trauma and are often overlooked in clinical cases.

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CHRONIC SCLEROSING OSTEOMYELITIS (GARRÈ)

BY JOSEPH G. WISHNER, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases, New York

This type of bone infection occurs frequently enough to cause some difficulty in diagnosis and treatment. It has thus far received scant attention from the orthopaedic surgeon. The literature has been fairly well covered in the isolated reports made by A. D. Kurtz, S. Fosdick Jones, and Hill and Penn. Five cases are added in the following report.

The most likely cause is bacterial, and trauma is usually the exciting factor. The difference between this and acute osteomyelitis is apparently one of degree. In three of our cases, the staphylococcus aureus was isolated. One must keep in mind the so called "silent foci" of Phemister. These, he believes, are mild foci of infection which have healed. They may be reactivated by trauma and so called to our attention.

From a pathological standpoint, two types of cases can be considered. In one, and this would be a true osteomyelitis, the marrow is first involved. It becomes cellular, shows an increased fibrosis, the cells of this fibroid tissue undergo metaplasia and become bone corpuscles. The marrow cavity is then entirely obliterated. In the second type the cortex is first invaded, the process starting as an osteitis. Here we have increased osteoblastic activity, so that the lamellae undergo progressive thickening and the marrow spaces become correspondingly reduced. The cortex becomes thickened, and the medullary cavity is diminished, but not obliterated. This bone is usually dense and like ivory, commonly described as eburnated bone. It is in this type that some bone lengthening may occur.

The symptoms are variable. They become important when adjacent joints are involved. In three of our cases (Cases 3, 4, and 5) our first impression was one of hip-joint disease.

DIAGNOSIS

The diagnosis in most of the cases is not easy. Early cases especially are difficult to classify. On the strength of symptoms and signs alone it is virtually impossible to detect, except in a typical involvement of the tibia where it can be considered. It is simple to palpate thickening and elicit tenderness in a tibia or femur of a child, but quite impossible when the upper third of the femur is affected.

The x-ray is the one important aid in diagnosis, and this helps only in the late cases. An error is most apt to be made before definite bone changes are evident. Case 5 was treated as an arthritis of the hip for one year before the femoral thickening appeared. Case 3 was unclassified for some time.

The laboratory is of little help. There is usually slight elevation in leucocyte count. The Wassermann reaction is important.

TABLE I
DIFFERENTIAL DIAGNOSIS (CLINICAL)

	Garrè	*Syphilis*	*Sarcoma*
Onset Fever	Usually present	None	None
Glandular Involvement	None	Frequently present	Occasionally present
Infiltration of Soft Parts	None	None	Present. Skin adherent
Loss of Weight	None	None	Present
Cachexia	None	None	Present
Wassermann	Negative	Usually positive	Negative

Differential diagnosis is extremely vital. Even in late cases, where x-ray findings are definite, it may be difficult to arrive at correct diagnosis. Its striking similarity to luetic osteoperiostitis and sarcoma is responsible for many delays in treatment. Here consideration of all signs and symptoms comes into use. The history, the course, the laboratory findings, and roentgenograms must be gone into carefully. Another possible source of error is a rare type (healed?) of osteitis fibrosa. Kocher believes that a considerable number of cured sarcomata are merely sclerosing osteomyelitis of long bones.

Tables I and II give the essential clinical and roentgenographic features of syphilis, sarcoma, and sclerosing osteomyelitis.

TABLE II
DIFFERENTIAL DIAGNOSIS—BONE CHANGES (ROENTGENOGRAPHIC)

	Garrè	*Syphilis*	*Sclerosing Osteogenic Sarcoma*
Periosteum	No involvement	Involved irregularly	Irregular involvement perpendicular to shaft
Cortex	Thickened symmetrically	Thickened irregularly	Thickened (one side) or destroyed
Medulla	Narrowed or obliterated	May or may not be narrowed	Destroyed
Bone Production	Within shaft	Within shaft	In or about shaft
Bone Destruction	None	None	Present
Soft Tissue	No change	No change	Bone production into soft tissues
Localization	Shaft or near joint	Any portion	Usually ends of long bones

TREATMENT

The treatment is operative. It is comparable to incision and drainage in other infections. Simple excision of a section of bone gives relief of symptoms and return of joint function, except where contractures are of long standing. Incision into bone apparently allows for a lessening of tension and reestablishment of circulation.

CASE REPORTS

Our cases singularly fall into two groups. In the first the involvement is in the shaft of a bone, the tibia, or femur. Here the symptoms are mild, merely local pain, the disability slight, and the diagnosis relatively simple. In the second group the involvement is near a joint. The three cases that form this group are strikingly similar and by a strange coincidence were under treatment at almost the same time. In each, the upper end of the femur was affected. Here the symptoms are more marked, the disability is severe, and the diagnosis difficult; and here treatment by drainage of the bone produced marked improvement. All cases were treated at the Hospital for Joint Diseases.

Case 1. J. D., aged six. Two years before began to have pain in the left leg, mostly at night. After a year pain became worse. Was taken to another hospital where diagnosis of obliterating osteomyelitis was made but nothing was done. At time of examination had pain in left leg, at times severe and worse at night. Examination disclosed a swelling of the left leg, an apparent anterior bowing of the tibia with some tenderness. White blood count was 15,500, with 68 per cent. neutrophils; Wassermann negative. No elevation of temperature was noted. The roentgenogram (Fig. 1) is self-explanatory.

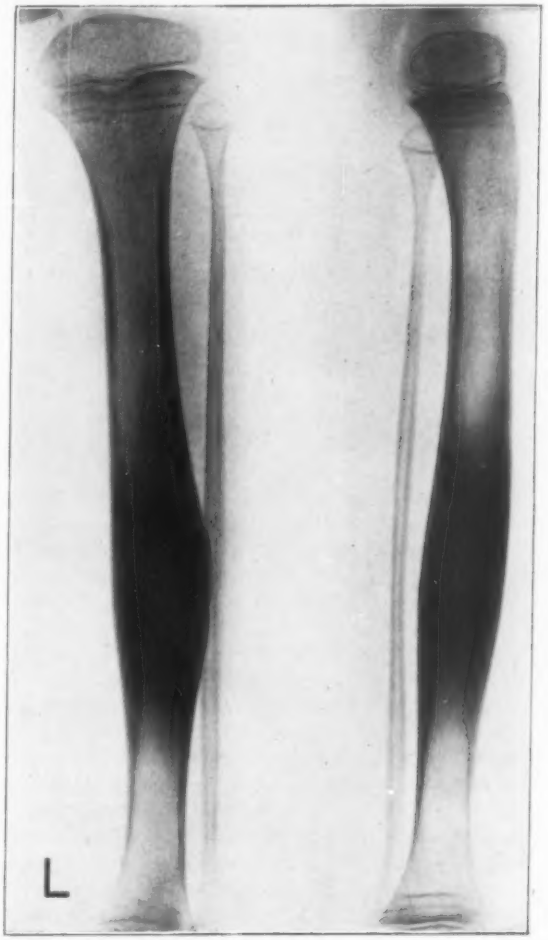

Fig. 1

Case 1. Shows increase in width of cortex, with some decrease in medullary cavity.

FIG. 2

Case 2. Shows increase in width and density of cortex in upper third of femur.

Operation was advised and performed. The periosteum was found abnormally thick and the cortex hard; no pus noted. Piece of tibia was removed. Wound was closed tight. Culture of marrow cavity revealed staphylococcus aureus. Pathologist reported that smear from marrow cavity showed chronic osteomyelitis, but that bone sections were normal.

The patient was relieved of pain. The wound healed by primary union. No postoperative elevation of temperature occurred. Letter from patient one year later reported complete relief of pain and gradual reduction of swelling. No late x-ray could be obtained.

CASE 2. K. C., aged ten, was admitted April 8, 1926. Had had pain in right thigh for about two years which followed a blow by a baseball. Pain was worse at night; not aggravated by walking. Had no limp. Examination was negative, except that the right thigh was one and one-half inches smaller than the left. Wassermann, negative; temperature normal. Roentgenogram (Fig. 2) showed osteitis of right femur, some endosteal bone proliferations, no destruction.

Operation:—Shaft of femur was exposed and surface of cortex found normal. Marked thickening of cortex, completely obliterating the medullary cavity, was found. About three inches of antero-internal cortex was removed. At one spot a mass of detritus, the size of a bean, was noted and curetted out. Wound was closed without drainage, no plaster applied. Culture was sterile; smear negative. Pathological report was osteosclerosis and fibrosis of bone with obliteration of medullary cavity. Patient was improved. A rise of temperature to 101 degrees occurred for two days postoperatively and then returned to normal. Wound healed by primary union.

Follow-up:—Two years later, no complaints, no disability.

CASE 3. P. K., aged eleven, was admitted first on January 27, 1929. Had had pain in right hip at intervals for one year. Pain was first noticed after strenuous exercise in school; later appeared after much walking. Pain was worse at night. Limping during the past six months had become progressively worse.

Examination:—Motion at right hip limited as follows:—angle of greatest flexion, 90 degrees; abduction, 30 degrees; internal rotation, 10 degrees; angle of greatest extension, 165 degrees; adduction, 10 degrees; external rotation, 15 degrees.

Roentgenogram (Fig. 3) showed atrophy of head and neck, irregular osteoperiostitis of shaft of upper third of femur. Neck seemed shortened. Laboratory report showed Wassermann negative; white blood cells, 10,500 with 75 per cent. neutrophils; calcium 10.6 grams, phosphorus 4.35 grams per 100 cubic centimeters. On account of little pain, patient was allowed to go home and return to dispensary for observation.

Her symptoms increased and she was readmitted March 4, 1929 (one month after first admission). Examination at this time showed: angle of greatest flexion, 110 degrees; abduction, 20 degrees; internal rotation, 5 degrees; angle of greatest extension, 145 degrees; adduction, 10 degrees; external rotation, 10 degrees.

FIG. 3

Case 3. Shows irregular osteoperiostitis of inner aspect of upper third of shaft of femur; slight atrophy of head and neck.

Roentgenographic report: "Neck seems shortened. There is some atrophy of head and neck; there is an irregular osteoperiostitis of the shaft of the upper third of femur on the inner side."

Operation, March 6, 1929. Eight-inch incision, exposing upper third of femur and neck. Cortex of neck near outer aspect was found very thin and gave impression of egg-shell crackle; it looked bluish. The trochanter minor was apparently replaced by an overgrowth of cortex. This was removed for distance of two inches. Although markedly thickened, the cortex was not unusually dense. On opening the medullary cavity, a gush of yellowish material was observed. This appeared to be broken down fat marrow. A drill hole was made up into the head, but revealed nothing. Wound was closed tight and light plaster-of-Paris spica applied. Temperature before operation was normal; afterward there was a rise to 101 degrees for two days and a return to normal.

Pain was relieved after operation. Plaster was removed in three weeks. Patient walked with crutches for several weeks. Culture showed a scanty growth of staphylococcus aureus. Pathological report:—Chronic osteomyelitis.

Follow-up, May 19, 1931. No pain; no limp. Flexion was limited to 90 degrees, otherwise motion at hip was normal. Roentgenograms showed that neck was assuming normal shape; width of shaft through trochanter was nearer normal. There was still evident increase of density along inner border of upper two inches of shaft and lower border of neck.

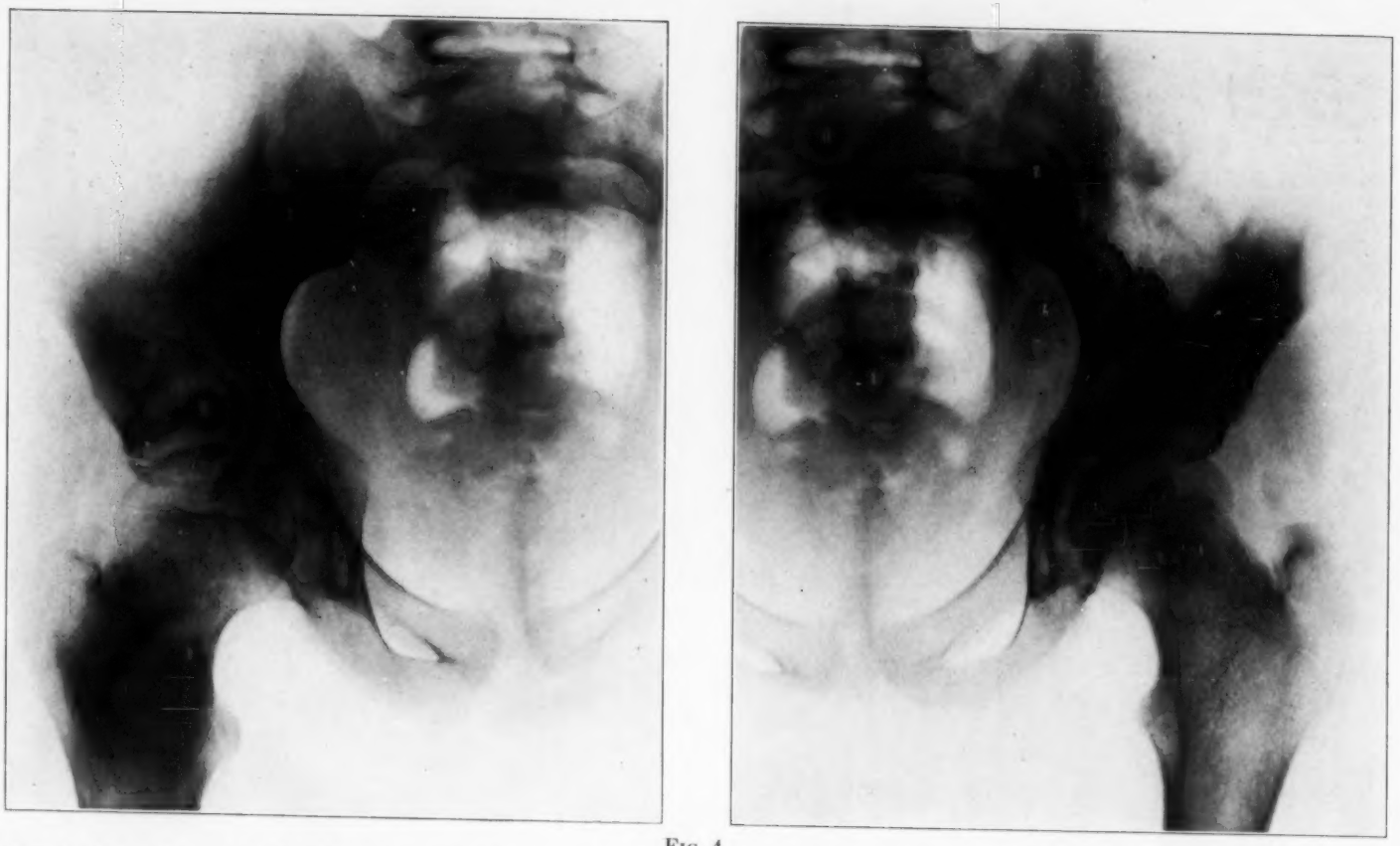

FIG. 4

Case 4. Shows increase in density of cortex of right femur and some widening at the base of the neck; there is a localized area of rarefaction suspicious of abscess.

FIG. 4-A. Right hip.

FIG. 4-B. Left hip.

Fig. 4-B. Left hip.

Case 4. Jennie C., aged twelve, was admitted May 13, 1929; discharged June 25, 1929. Complained of pain in right hip, which began two months before while doing exercises in school. Pain was persistent and worse at night. Girl walked with limp. This limp appeared soon after onset of pain; was increasing.

Examination: Patient walked with limp on right side; right hip was held in flexion. There was slight tenderness over greater trochanter. Angle of greatest flexion was 80 degrees; angle of greatest extension, 160 degrees; internal rotation limited; external rotation normal. Measurements were:
Right A*—31 inches;
Right tibia—12½ inches;
Right calf—8½ inches (atrophy);
Left A* —31 inches;
Left tibia—12½ inches;
Left calf—8¾ inches.
Blood count showed hemoglobin of 80 per cent.; white blood cells 7,950, with 63 per cent. neutrophils. Wassermann was negative; quantitative tuberculin test, negative. X-ray 16970 (Figs. 4-A and 4-B) showed an increase in width of femur at base of the neck; some increase of density in bone in this area, and slight suspicion of bone abscess. This case was similar to Case 3. Operation was decided on.

Fig. 5

Case 4. Follow-up x-ray. Upper end of shaft and neck are almost normal; outer cortex shows osteotomy.

Operation, May 15, 1929. Greater trochanter and anterior aspect of femoral neck at intertrochanteric line were exposed. Periosteum was much thickened. Piece of bone was removed. It looked pale, had a white, ivory-like appearance and felt hard as ivory. No pus was noted; marrow seemed pale. Specimen was sent to laboratory for culture and microscopic examination.

Pathological report: "Low-grade non-suppurative inflammatory process with atrophy; slight resorption and some periosteal new bone formation." Smear was negative; culture, sterile; guinea-pig inoculation, negative. Because a rather large piece of bone was removed, vaselin gauze packing was inserted to fill in cavity and plaster-of-Paris spica was applied. This was removed in four weeks. Temperature was normal before and after operation. Patient was discharged June 25, 1929, with wound practically healed.

Follow-up, January 1932. No complaints; walks without limp. Range of motion in right hip is excellent. Angle of greatest flexion, 50 degrees; angle of greatest extension, 180 degrees; rotation normal. X-ray (Fig. 5) shows neck and upper end of shaft almost normal. Area of excavation just below trochanter is filling in. Where abscess cavity was suspected, bone is negative.

* Anterior superior spine.

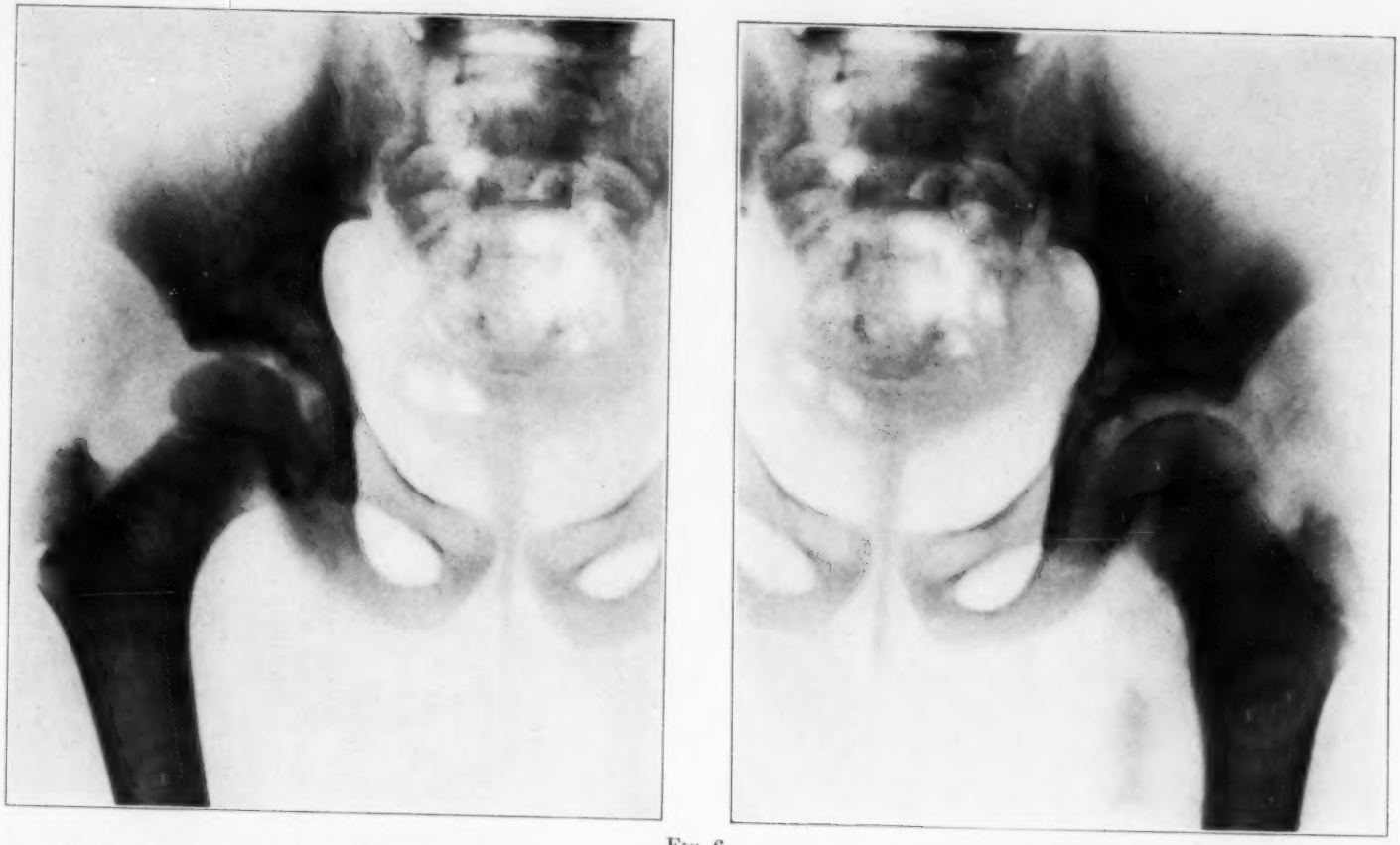

FIG. 6.

Case 5. Shows increase in density and width of cortex of left femur, inner aspect of upper third; slight atrophy of head of femur.

FIG. 6-A. Right hip.

FIG. 6-B. Left hip.

Fig. 6-B. Left hip.

Case 5. S. A., aged ten. First Admission, November 6, 1929–November 26, 1929. Second Admission (one year later) September 10, 1930–December 7, 1930. In May 1929 had tonsillitis. After this illness had pain in left hip and limp on left side. Treated in Out-Patient Department with plaster spica. Pain was relieved, but limp remained. Admitted into hospital.

Examination was negative except for local condition about left hip. All motion was limited; flexion contracture of 20 degrees. Blood count showed white blood cells, 7,750, with 60 per cent. polymorphonuclears. Wassermann was negative; tuberculin test, negative. Roentgenogram 19087 (Figs. 6-A and 6-B), taken November 6, 1929, showed slight atrophy of capital epiphysis; slight increase in density of bone on inner border of cortex of neck and upper two inches of shaft of femur.

Fig. 7

Case 5. Shows increase in density of inner cortex of femur with increase in width of femur at base of neck; compare with Fig. 3.

Treatment:—Traction to overcome flexion contracture; plaster spica three months.

Since limp continued and flexion contracture returned, he was readmitted on September 10, 1930. X-ray 23013 (Fig. 7) showed increased density of neck and upper two inches of shaft. Neck was thickened and shortened. There was a striking similarity to picture of Case 3 (Fig. 3).

Operation, October 20, 1930. Greater trochanter and shaft were exposed. Cortex was apparently negative (inner cortex was not carefully exposed). Several drill holes were made and curettings sent to laboratory. No pus was encountered. Wound was closed tight and spica applied for two weeks. Temperature before operation was normal; afterward rose to 102 degrees for two days; then returned to normal. Had stitch abscess which cleared up in few days. Wore brace for three months.

Pathological report. "In one place increased connective tissue is observed with some cells that may be a nest of inflammatory cells." Smear was negative. Culture showed staphylococcus aureus.

Discharged December 7, 1930 with brace.

Follow-up, January 1932. No complaints, no disability. Complete range of motion of left hip except for slight limitation of internal rotation. X-ray (Fig. 8) shows that increased density of inner aspect of neck and shaft has disappeared; neck, though still thickened, is more nearly the normal shape.

FIG. 8

Case 5. Follow-up x-ray shows return to normal of cortex of femur; neck is still shorter and femur wider at base of neck.

SUMMARY

Five cases are reported which fall into two distinct groups. In the first group there is the type of case most often reported as chronic sclerosing osteomyelitis. Here the shaft of a long bone is involved, the symptoms are fairly clear, and the diagnosis readily established by the roentgen ray. No difficulty was encountered in their treatment.

The second group is more complicated. In the reports searched no mention of such a type was noted. The similarity in localization, symptoms, and roentgen-ray findings is interesting. All were treated in the same way; they were relieved by operation and have remained well. The wounds stayed closed and no recurrences, either local or metastatic, have thus far been observed. In two, cultures gave growth of staphylococcus aureus. Late x-ray examinations show a gradual return to normal contour and texture, once the irritant has been removed.

Acknowledgment with thanks is made to Dr. Leo Mayer, Dr. Harry Finkelstein, and Dr. Herman C. Frauenthal for permission to use their cases.

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RECURRENT DISLOCATION OF THE SHOULDER. NICOLA OPERATION

With Report of Cases *

BY MARCUS H. HOBART, M.D., F.A.C.S., EVANSTON, ILLINOIS

From the Department of Surgery of Northwestern University Medical School

In 1929 Nicola [1] introduced his operation for recurrent dislocation of the shoulder which has as its principle the retention of the head of the humerus within the glenoid fossa by means of the long tendon of the biceps. This tendon is transplanted into a tunnel through the humeral head and acts to hold the head in place.

This operation of transplanting the long tendon of the biceps seems very logical. It is anatomical, physiological, and simple; and it remains only to stand the test of time as to its results. There is the theoretical objection that the tendon may give way, but that is also possible with any of the other methods, and in this operation the living biceps tendon should be a better and more lasting protection than any other form of suture or stay.

We suggest and have used two modifications of the technique originally devised by Nicola; these have been in part adopted by him, although not yet reported.

1. An incision is used about a half-inch posterior to the anterior border of the deltoid, and the fibers of that muscle are spread longitudinally. With this incision there is less danger of damaging the cephalic vein, which is located at the anterior border, and exposure of the bicipital groove and tendon can be obtained without cutting any of the fibers of the deltoid at their origin on the clavicle.

2. The tunnel in the humerus is so directed that the entrance for the tendon is near the proximal end of the bicipital groove and not in the middle of the head of the humerus (Fig. 1).

This gives a more normally anatomical course for the tendon, obviates any sharp angle in it, and avoids the continual crushing effect of the humeral head on the tendon in the glenoid fossa.

TECHNIQUE OF TENDON-TRANSPLANTING OPERATION

1. Thorough sterile preparation of the shoulder field of operation twenty-four hours in advance. This means shaving area, green soap, ether, alcohol, tincture of iodin, and a sterile dressing. Repainted with tincture of iodin at time of operation.

2. "Lane-style" technique throughout the operation,—*i.e.*, instrument operation.

* Reported before the Joint Meeting of the American Academy of Orthopaedic Surgeons and the Clinical Orthopaedic Club at Chicago, Illinois, January 13, 1933.

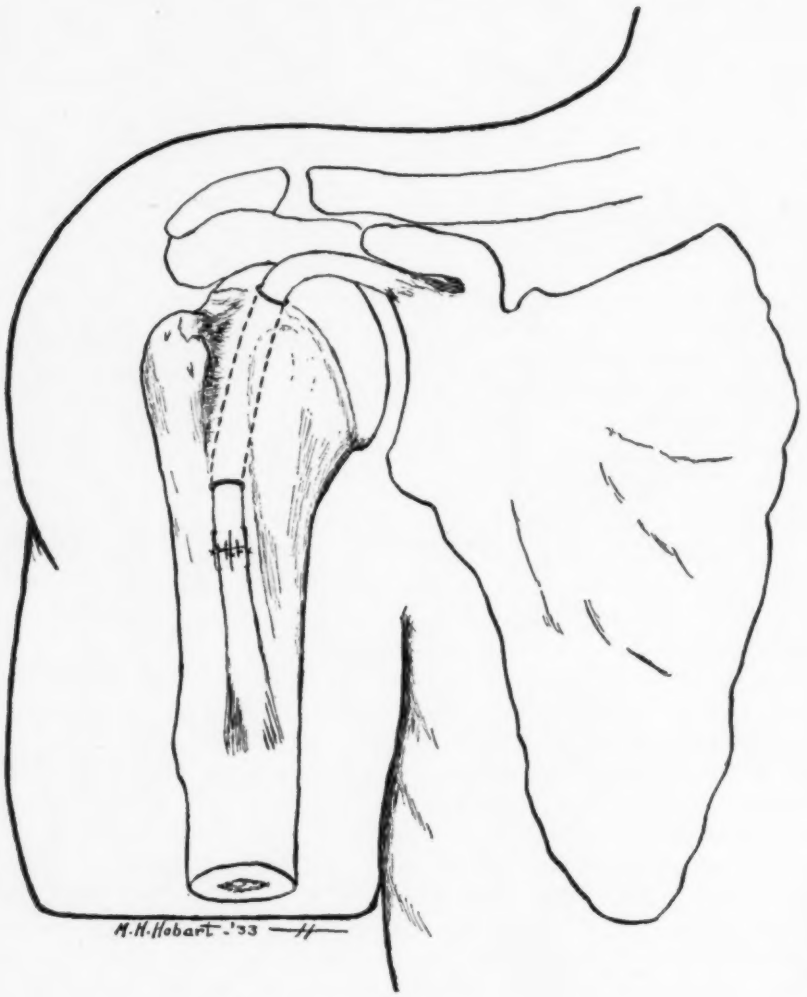

FIG. 1

Modified Nicola operation for recurrent dislocation of shoulder, showing the tunnel for the long tendon of the biceps muscle through the humerus under the bicipital groove.

3. Position on the table: patient on his back with sand bag under shoulder, humerus rotated outward about ninety degrees. This allows the bicipital groove to point anteriorly. The elbow is flexed to about forty-five degrees and kept in that position for two to three weeks post-operatively.

4. General anaesthetic used.

5. Incision, as above, one-third to one inch posterior to anterior border of deltoid muscle, and fibers separated longitudinally, exposing the capsule near the bicipital groove.

6. The tendon of the long head of the biceps is exposed by cutting

the transverse humeral ligament over the tendon in the bicipital groove, and splitting the capsule in the direction of the tendon. The bicipital branch of the circumflex artery which accompanies the tendon in the groove should be avoided if possible.

7. The long tendon of the biceps is divided between stay sutures about one inch distal to the margin of the transverse humeral ligament.

8. A hole is drilled through the neck and head of the humerus, beginning just below the transverse humeral ligament, and using a quarter-inch drill. This is so directed that it comes out near the proximal end of the bicipital groove at the margin of the humeral head, as above described.

9. A probe is passed through this tunnel, from below upward, and the cut end of the proximal tendon threaded onto it and pulled back through the tunnel. The two cut ends of the biceps tendon are sutured together with black silk.

10. Tension is made on the proximal part and sutures passed through the tendon and periosteum to prevent tension on the newly sutured section of the tendon.

11. The transverse humeral ligament and capsule are sewed with a continuous, No. 1, plain catgut suture; the skin closed with silk or dermal suture.

12. The arm is put up in a Velpeau bandage, reenforced with adhesive plaster, with the elbow flexed to forty-five degrees, and left there for three weeks.

The patient is then allowed to resume motion gradually. Massage, gentle motion, and heat are advisable. The patient is cautioned not to abduct arm completely for a number of weeks.

CASE REPORTS

Case 1, H. S., male, aged twenty-six years. Fifteen or sixteen dislocations of right humerus previous to May 12, 1932. Operation (Nicola) at Cook County Hospital. After leaving hospital in two weeks, had an accident resulting in fracture of right elbow which healed perfectly, with good motion. After that he kept the arm completely abducted each night for three weeks, on the advice of someone else. He had used the arm for everything. About December 20, 1932, while putting on a heavy overcoat, he said the shoulder went out again and right back. Since that time he has had no more trouble.

Case 2, E. G., male, aged nineteen years. Injured left shoulder one year ago playing football, twelve recurrent dislocations. November 17, 1932, operation (Nicola with anatomical replacement of tendon), at Cook County Hospital. Result: all motion, no recurrence.

Case 3, C. J., male, aged twenty years, had had six dislocations of right humerus. December 29, 1932, operation (Nicola, revised as in Case 2), at Cook County Hospital. Result: using arm, all motion present, no recurrence.

SUMMARY OF CASES

Of the three cases operated on, Case 1 (Nicola) has had one slight recurrence, but this man has given his shoulder much abuse and violent usage since the operation, ten months ago. Cases 2 and 3 (Nicola, with anatomical replacement of biceps tendon) have given good results.

CONCLUSIONS

1. The Nicola operation offers a comparatively simple means of treating recurrent dislocations of the shoulder.

2. The revised technique as here suggested, of placing the long head of the biceps through a tunnel, nearer the bicipital groove, instead of through the humeral head, gives a more anatomical result and should obviate angling the tendon and crushing it in the glenoid fossa.

3. Enough time has not elapsed, nor have enough cases been reported to determine its permanent value.

4. Three Nicola operations are reported.

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FIXED SKELETAL TRACTION IN FRACTURES OF THE LEG

BY RALPH M. CARTER, A.B., M.D., F.A.C.S., GREEN BAY, WISCONSIN

For the treatment of difficult fractures of the leg below the knee, the application of fixed skeletal traction by means of the Kirschner wire has proved highly successful in my experience.

The necessary equipment consists of a Kirschner wire outfit, a traction frame for fractures of the lower leg as suggested by Böhler, and a so called Marburg distraction apparatus. This latter consists of two Kirschner traction bows, whose extremities are drilled to receive the ends of detachable lateral bars, connecting one bow with the other by means of turnbuckles; the lengths of these bars may be varied as indicated.

To make use of this method in fractures of the tibia, the patient is anaesthetized, a Kirschner wire is put through the os calcis, in the usual manner, and the traction bow applied. The leg is then placed in the traction frame, as shown in Figure 1. In doing this, there must be sufficient padding at the bend of the knee to prevent undue pressure on the skin; a spring balance is also interposed between the traction bow and the traction screw. This is shown in the illustration.

The traction screw at the end of the frame is now turned down until the spring balance registers about twenty-five pounds; in most cases this will be found to be sufficient to overcome any shortening which may be present and, upon palpation at the site of fracture, the ends of the fragments will be found to be in contact. In certain cases, apparently in those in which the sharp end of a bony fragment has become embedded in muscle, more traction is necessary; in such cases, it may readily be applied by means of the traction screw, until the spring balance shows forty to forty-five pounds. In those cases in which this amount of traction is necessary, a blanching of the toes and foot will occur, due to compression of the blood vessels at the knee. This need occasion no alarm; such traction, if necessary, may be maintained for fifteen to twenty minutes, or even longer, with no after-effects whatever. As soon as the cast is applied and the traction relieved, the toes immediately take on their natural color, and no pain or soreness at the knee results.

When the shortening has been overcome by a sufficient amount of traction, palpation will usually show that the fragment ends are in contact; if there is a gap in the continuity of the bone, the traction is released until this gap disappears.

By means of a portable x-ray unit, films are now made in two planes. In most cases, satisfactory reduction will be found to have taken place; occasionally some lateral displacement may persist, which is readily corrected by manual pressure on opposite sides of the leg.

Not infrequently, also, there is seen to be overcorrection of the shortening, with slight diastasis of the fragment ends, particularly in

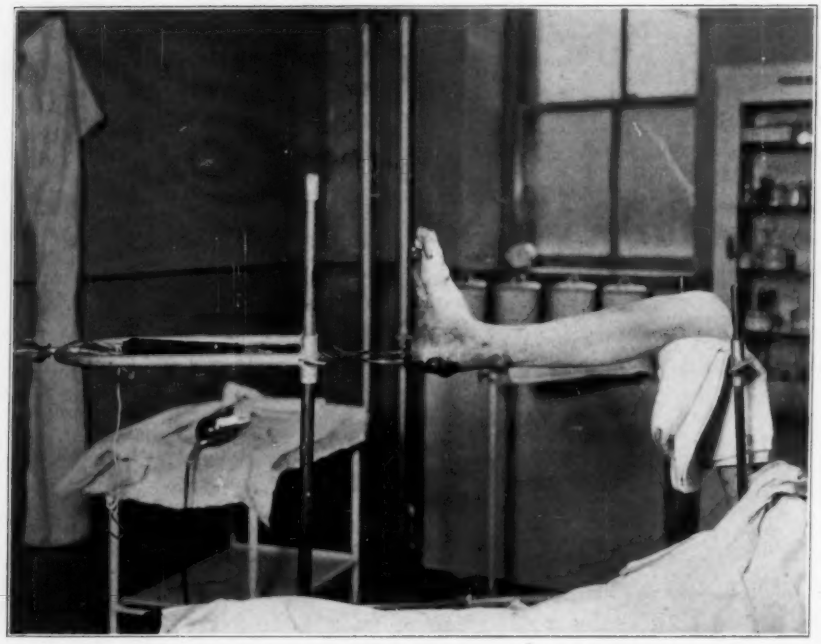

FIG. 1

Leg in traction frame, showing wire through os calcis, padding at knee, and spring balance. Reduction of fracture complete.

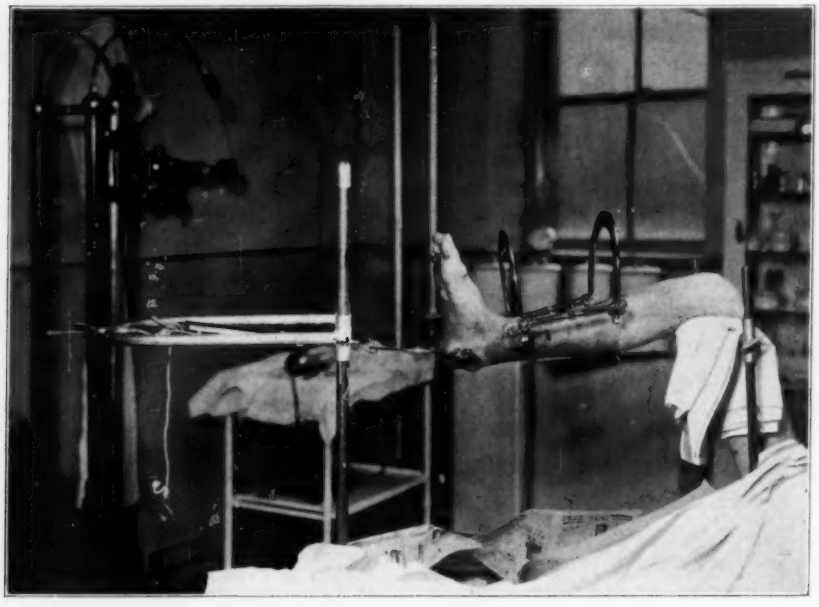

FIG. 2

Apparatus for fixed traction in cast in place. Leg ready for plaster.

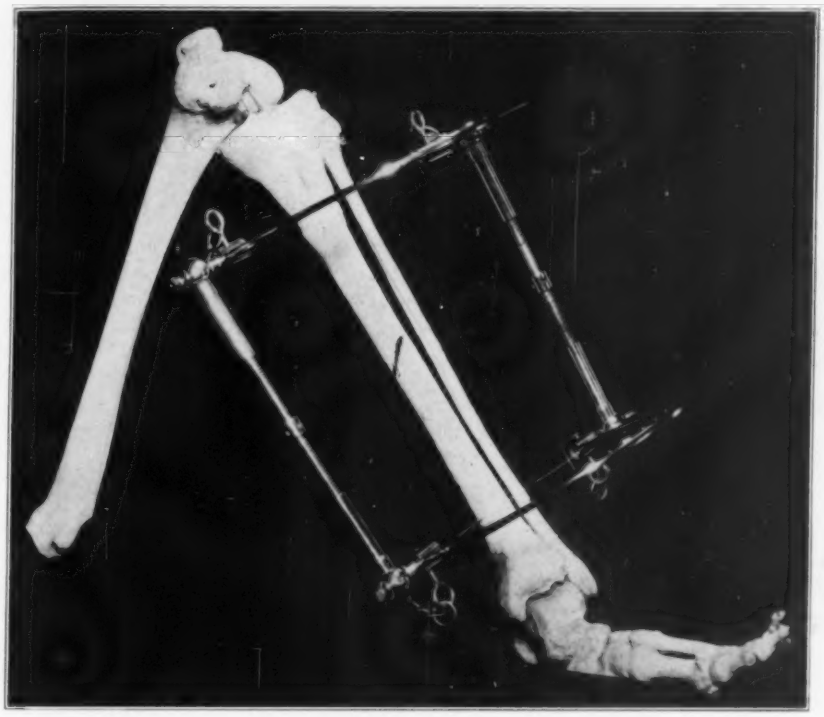

FIG. 3

Skeletal relationship of wires. Site of fracture indicated by black line.

transverse or slightly oblique fractures. If this is the case, the traction must be further released. This last point is particularly important; with the powerful traction, overcorrection and separation of the fragment ends readily take place, and, if allowed to remain, will give rise to delayed union, if not to its complete absence.

When reduction is satisfactory, the next step in the procedure is carried out. Two heavy Kirschner wires are put through the tibia above and below the site of the fracture. Over the protruding ends of both wires, before the traction bows are applied, are slipped small set screws, which for the time being are left loose. The traction bows are now put in place and the wires tightened as usual. The lateral bars of the distraction apparatus are next fixed to the two Kirschner bows, and the turnbuckles adjusted to the proper length. By this means, the fragments are firmly fixed in their reduced position, and no displacements can possibly take place during the application of the cast. This step in the procedure is shown in Figure 2. The skeletal relationships of the two wires are shown in Figure 3.

An unpadded plaster cast is now applied, beginning with a posterior molded splint. In applying this cast, great care must be taken to see that it fits snugly about the wires in the shaft of the tibia. The leg with the cast applied is shown in Figure 4.

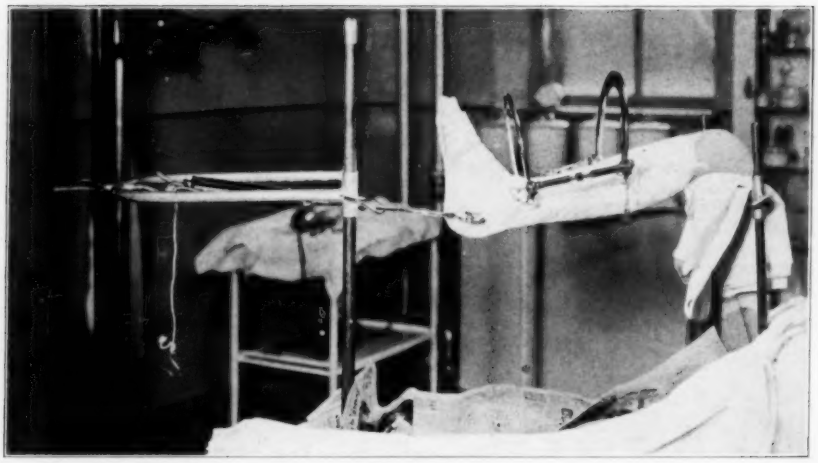

FIG. 4

Leg still in traction frame with cast applied.

As soon as the cast has firmly set, the leg is removed from the traction frame. The small set screws which were previously slipped over the ends of the wires are brought snugly up against the cast and tightened. By this means, the tension is kept on the wires in the absence of the traction bows. The latter, together with the lateral bars, are now removed and the protruding ends of the wires cut off close up to the set screws. The Kirschner wire through the heel is also removed. The dressing at this stage is shown in Figure 5. It is completed by throwing a few turns of plaster bandage over the set screws as a protection.

By means of this procedure, difficult fractures of the tibia can be readily reduced, and what is more important, owing to the fact that the fragments are firmly united to the cast by means of the wires, new displacements cannot take place, and reduction is easily maintained until the bony union is firm. The roentgenograms from an illustrative case are shown in Figures 6 and 7.

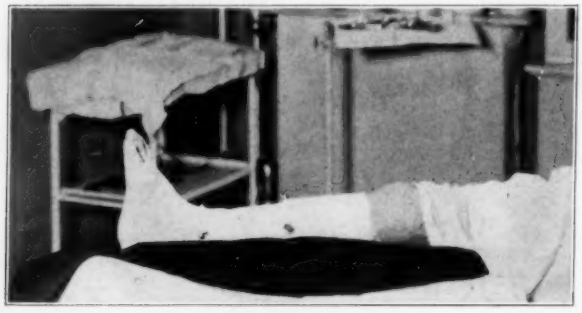

FIG. 5

Completed dressing. Note set screws maintaining tension of wires.

The distraction apparatus alone can be used to effect and maintain reduction, although it is preferable to use it in connection with a frame and traction to the os calcis, as above described. If, however, a traction frame is not available, the method of use is briefly as follows:

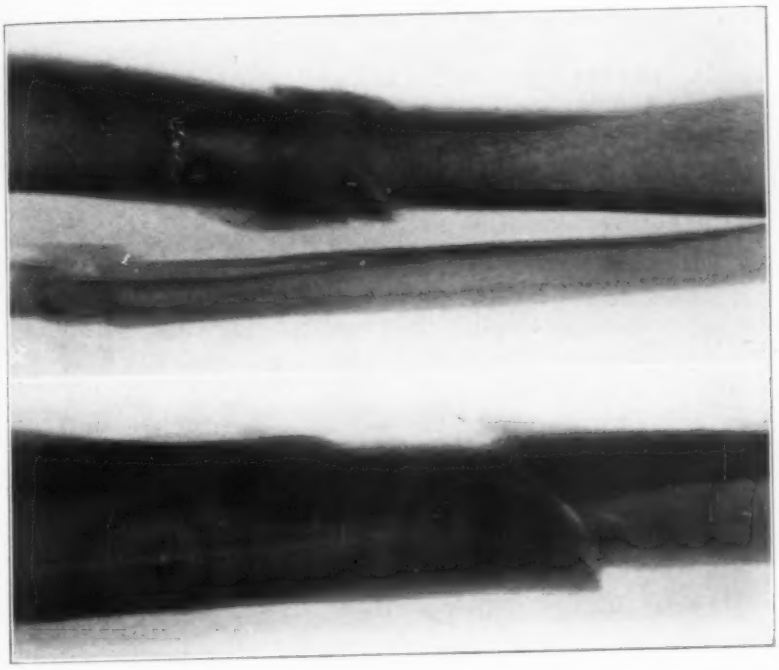

FIG. 7

Fracture of both bones of leg after treatment.

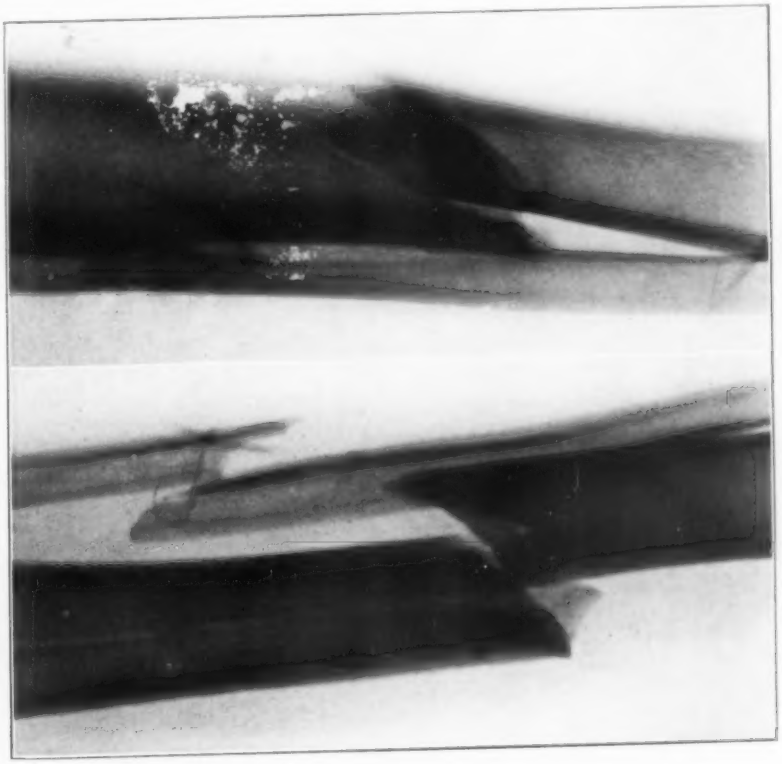

FIG. 6

Fracture of both bones of leg before reduction.

Under strictly aseptic precautions, as always, the wires are put through the bone above and below the site of fracture. The set screws, bows, and lateral bars are then applied, and traction is obtained by lengthening the lateral bars sufficiently to bring the broken ends into contact. An unpadded cast is then put on, the set screws tightened, and the apparatus removed. Without the use of the traction frame, however, unless great care is exercised, new displacements are possible during the manipulations attendant upon the application of the cast, and, for this reason, the use of the frame is preferable.

The following day, after the plaster has firmly set, the usual iron stirrup is applied to the cast, extending below the sole of the foot, and the patient becomes ambulatory.

The progress of callus formation is noted by means of an occasional roentgenogram. In most cases, union is sufficiently firm at the end of about four weeks so that the wires and cast may be removed and a new cast without wires put on if desired, without danger of causing displacement of the fragments. However, in the absence of any indication to the contrary, this is not necessary, and the original cast may remain until union is firm, and a cast is no longer needed.

This method of treatment is reported because it is one which gives highly satisfactory results in a class of fractures which frequently occasion extreme difficulty. No originality is claimed for it; the same principle is utilized by Böhler in fractures below the knee, the difference being that he makes use of rustless steel nails for obtaining the fixed traction instead of the Kirschner wire. These nails must be driven or forced through the bone; this of course can be readily done, but the insertion of the Kirschner wire is much simpler and easier. The nails also give rise to much more tissue damage than do the wires, on account of their much larger size; hence, irritation and the chance for infection are increased. For these reasons, I feel that the method which makes use of the wires and which has been described is preferable.

NOTE.—Since the above article was accepted for publication, in reviewing some fracture literature, I have found a paper on the same subject by Dr. J. Warren White, of Greenville, South Carolina (White, J. W.: Plaster Cast, Bone Pin Method in Fractures of the Lower Leg. Southern Med. J., XXV, 218, 1932). The method of treatment described in his paper is similar in many of its details to the one described by me. Although my work has been done independently and with no knowledge of his method, I feel that in justice to Dr. White, this acknowledgment should be made. *R. M. Carter.*

EXTRA-ARTICULAR BONE-GRAFT TREATMENT FOR TUBERCULOSIS OF THE HIP JOINT

With a Special Study of the Primary Failures of Fusion

BY SYLVAN L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

From the Shriners' Hospital for Crippled Children

Sufficient time has elapsed since the introduction of the extra-articular graft operation to allow some deduction to be made as to the advisability of instituting this particular operative procedure for the cure of tuberculosis of the hip joint. To date the published reports are not sufficiently large to allow the surgeon to formulate some definite conclusions, but there should be an increasing number in the next few years.

In interpreting the reports, one must bear in mind certain significant facts that may play a part in leading to error. Thus there is always the possibility of a recrudescence after an apparent cure, even after the lapse of a number of years. However, one may be reasonably certain of a cure if a firm, bony ankylosis has taken place in the diseased joint. It must not be forgotten that there is always a chance for error in diagnosis, especially in the extra-articular method, as particular effort is made to avoid invasion of the diseased joint, and no material is obtained for certain diagnosis by microscopical examination and guinea-pig test. In other words it becomes necessary to rely on the presumptive evidence furnished by clinical history and findings and roentgenographic examinations.

In the papers by Albee[1], Hass[2], Maragliano[3], Kappis[4], Hibbs[5], Wilson[6], Ghormley[7], Sorrel[8], Eikenbary[9], Schumm[10], Mathieu[11], Nové-Josserand[12], Leriche and Stricker[13] different modifications of the extra-articular and intra-articular bone-graft operations are described in detail. Good results have been obtained by all of the methods but here again sufficient statistics have not been presented to allow the drawing of any conclusions as to the preferable type. Even after the publication of a large number of reports it will be necessary to exercise care in drawing conclusions and avoiding an erroneous interpretation. A few of the facts that must be considered are: the age of the patient at the time of operation, the duration of the disease, virulence or acuteness of the process, careful operative technique, postoperative care, time of observation, and careful follow-up of the patient. It is possible that one type of operation may give a uniformly higher percentage of good results. It is believed that a certain number of failures will occur regardless of the type of operation. A study of these unsuccessful results in an effort to determine the causative factors should provide some interesting results. It is to be hoped that the details presented in this report may aid in solving some of

the problems that are encountered and decrease the failures, or lead the way to a uniformly successful method.

The present study is based upon fifty patients operated upon at Shriners' Hospital in San Francisco with the extra-articular bone graft. The technique of the operation was relatively uniform throughout the series. The joint capsule was exposed by a Smith-Petersen approach, after which a free or pedicle graft from the ilium was utilized to bridge the gap from the raised-up trochanter to the side of the ilium outside of the joint capsule. If tuberculous material was encountered in the ilium or elsewhere outside of the capsule, the operation was completed in the usual manner. Some of the cases were operated upon even in the presence of a persisting sinus. The operative wound was closed in layers, after which a single or double plaster spica was applied. The patient was kept recumbent until union was well established.

There was no operative mortality in this group of patients and there was a very noticeable beneficial improvement in the physical condition of all patients very soon after the operation. All the patients, with one exception, were definitely benefited by the operation. One patient who had a sinus at the time of operation made good progress, and union was almost complete when he developed a fatal meningitis about the eighth month after operation.

Sinuses were present in six patients at the time of operation, but healing took place in all but one patient. Sinuses appeared in three patients after operation. One of these subsequently healed and it is anticipated that the other two, which are gradually healing, will close permanently.

In twelve patients tuberculous material was encountered during the operation, but a sinus followed in only one patient.

The average age of the patients at the time of operation was seven years.

The average duration of the disease before operation was four and three-tenths years.

The average time after operation before the patient walked was one year and four months for those requiring one operation.

The longest time period of observation since operation has been eight years. The disease appears to be cured or arrested in every patient, but it will take a longer period before more definite final conclusions can be drawn.

SPECIAL STUDY OF PATIENTS REQUIRING MORE THAN ONE OPERATION

In reviewing these fifty cases it was rather surprising to find that twenty patients, or forty per cent. of the total, required more than one operation before a successful result was obtained. In view of the large number of secondary operations, it was thought that a detailed study would throw some light on the cause of the failures and possibly pave the way for a method of securing more primary successful results. It may

be possible to determine from this study the type of case in which the prognosis for operative success will be poor. If a failure can be anticipated, then some supplementary procedure may be instituted to assure a good primary result. The study will be taken up with regard to the following subjects:

1. Age at time of operation.
2. Duration of disease before operation.
3. Time after operation before patient was able to walk unassisted.
4. Type of deformity at time of operation.
5. Appearance of head of femur in roentgenogram.
6. Appearance of acetabulum in the roentgenogram.
7. Distance of trochanter from the ilium.
8. Mobility of femur at time of operation.
9. Presence of sinus at operation.
10. Presence of abscess at operation.
11. Tuberculous material encountered during operation.
12. Progress of disease process.
13. Acuteness of the disease.
14. Use of free or pedicle iliac graft.
15. Single or double spica applied after operation.

For simplicity of study it may be best to group the subjects under several headings, as: (1) time element, (2) pathological and clinical findings, (3) operation. As nearly as possible each type will be tabulated and studied in relation to the patients requiring either a primary operation or a secondary operation.

TABLE I

AGE, DURATION, AND TIME BEFORE OPERATION

	Average Age at Time of Operation	Duration of Disease Before Operation	Time After Operation Before Patient Was Able to Walk Unassisted
Primary successful result	7.9 years	4.9 years	1.3 years
Secondary successful result	7.8 years	3.5 years	2.3 years

The average age at time of operation was about the same in both groups, but in general the patients were younger in the group requiring more than one operation.

The duration of the disease before operation was longer in those patients requiring only one operation. Thus it may be inferred that the longer the duration of the disease the more likely it is to be quiescent and, therefore, more amenable to treatment. This factor will be further elaborated in some of the other tables.

There was, of necessity, a longer time period in those patients requiring two or more operations.

TABLE II

DEFORMITY AT OPERATION

	Adduction Deformity	Abduction Deformity
Primary	60 per cent.	40 per cent.
Secondary	75 per cent.	25 per cent.

In Table II it is noticed that there was a larger proportion of cases with adduction deformity requiring more than one operation. This factor is not so important in view of the rather large number of cases in which a primary result was obtained in the presence of an adduction deformity.

TABLE III

PATHOLOGY

	Erosion of Head		Acetabular Involvement		Distance of Trochanter to Ilium		Mobility at Time of Operation	
	Slight	Great	Slight	Great	Short	Long	Slight	Great
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Primary	10	90	30	70	73	27	73	27
Secondary	30	70	25	75	50	50	50	50

It is evident from Table III that where there was a greater destruction of the head and acetabulum there was a correspondingly better chance for primary union. It is also noticed that, with a shortened distance from trochanter to ilium, as would occur with greater destruction, from an operative standpoint there would be a better chance of securing a good bone graft between the two points. It is also noticed that the less the mobility at the time of operation the greater are the chances of a primary successful result. These factors all work together in influencing a favorable result,—that is, greater destruction, less distance to be bridged, and greater fixation.

Also, as pointed out in Table I, the longer the duration the better are the chances of success, which is in accord with the other findings,—namely, the more the destruction the greater the tendency to fixation.

The presence of a sinus or abscess at the time of operation, or the encountering of tuberculous material, did not hinder the possibility of a primary success. This must not be interpreted as a desirable condition to have present, but the presence or encountering of tuberculous material does not necessarily spell disaster. In general, it is best to carry out the

FIG. 1

Type of lesion in which prognosis is good for primary fusion. Notice the marked destruction of the head and acetabulum and the short distance from the trochanter to the side of the ilium.

primary principles of this particular operation and avoid, wherever possible, the invasion of the diseased area.

The more rapidly and acutely the disease is progressing, the greater are the chances of primary failure. In other words, the more chronic the process the greater are the chances of obtaining a successful result.

FIG. 2

Primary fusion obtained in the marked destructive lesion.

TABLE IV

SINUS, ABSCESS, AND TUBERCULOUS MATERIAL AT OPERATION

	Sinus at Operation	Abscess at Operation	Tuberculous Material at Time of Operation
Primary	12 per cent.	12 per cent.	27 per cent.
Secondary	14 per cent.	10 per cent.	20 per cent.

There appears to be no advantage of the pedicle iliac graft over the free iliac graft. The removal of the cartilage from the trochanter did not increase the chances of primary successful operation. The application of a double plaster spica did not prevent the failures. In fact there were fewer primary successes when a double spica was applied.

SUMMARY ON CAUSE OF PRIMARY FAILURES

The longer the duration, the slower the progress, and the more chronic the disease, the greater are the chances of a primary successful extra-articular arthrodesis.

FIG 3

Type of lesion in which the prognosis is for primary failure. Notice the long distance from trochanter to ilium and relatively well preserved outline of the head.

Fig. 4

Fracture and non-union of the extra-articular bone graft.

Fig. 5

Secondary successful result after supplementary graft operation.

TABLE V
ACTIVITY OF THE DISEASE

	Rapid	Slow	Acute	Chronic
Primary	20 per cent.	80 per cent.	26 per cent.	74 per cent.
Secondary	40 per cent.	60 per cent.	30 per cent.	70 per cent.

The greater the destruction of the head and involvement of the acetabulum and, necessarily, a closer approximation of trochanter to the side of the ilium, the more the likelihood of obtaining a primary successful result (Figs. 1 and 2). The greater the destruction, the longer the duration, and the more chronic the process, the easier will be the operative procedure, and the more certain the securing of a fusion by the first operation.

TABLE VI
FACTORS CONNECTED WITH THE OPERATION

	Free Iliac Graft	Pedicle Iliac Graft	Cartilage Removed from Trochanter at Operation	Cartilage Not Removed from Trochanter
Primary success	66 per cent.	34 per cent.	24 per cent.	76 per cent.
Secondary success	55 per cent.	45 per cent.	20 per cent.	80 per cent.

	Single Spica After Operation	Double Spica After Operation
Primary success	80 per cent.	20 per cent.
Secondary success	55 per cent.	45 per cent.

The more the mobility, the less the chances of fixation. In the early acute cases the mobility is greater and it is technically more difficult to secure fixation while the extra-articular graft is uniting at its ends. The long leverage arm of the extremity puts a severe strain on the grafted area when there is mobility at the time of operation and reduces the possibility of union (Figs. 3, 4, and 5).

The presence of a sinus, an abscess, or the encountering of tuberculous material during the operation did not seem to be a causative factor for primary failures. It is preferable, however, to work in a clean field and uphold the primary principles of the extra-articular method. The removal of the cartilage from the trochanter or the application of a double plaster spica did not reduce the number of primary failures.

CONCLUSIONS

1. The extra-articular-graft method for fixation in tuberculosis of the hip joint in children is a definite, curative, operative procedure and reduces markedly the time of treatment.

2. In the primary successful cases, the patients were able to walk unaided one and one-third years after operation, although the average duration of the disease before operation was nearly five years.

3. The longest lapse of time since operation in this series is eight years. There is every indication of permanent cure in this and the other cases of the series.

4. Successful results may be obtained even though a sinus or abscess is present at the time of operation, but a clean field is preferable.

5. Forty per cent. of the patients required more than one operation before successful result was obtained.

6. The failure of the primary operation was found in the acute cases of short duration, in which there was little destruction of the head and involvement of the acetabulum, adduction deformity, and considerable free movement in the joint at the time of the operation.

7. In those cases where a primary failure may be anticipated, it is recommended that a supplementary osteoperiosteal graft from the tibia or upper end of the femur be used in conjunction with the graft from the ilium.

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CONTRIBUTION TO THE QUESTION OF SPINAL FUSION IN TUBERCULOUS SPONDYLITIS IN CHILDHOOD*

BY ERNST FREUND, M.D., VIENNA, AUSTRIA

Fellow, Brown Orthopaedic Research Fellowship, Hospital for Joint Diseases, New York City

In spite of the fact that the operative treatment of tuberculous spondylitis by spinal fusion has been practised for more than twenty years, there is still lack of unanimity in regard to the indications and to the therapeutic value of the operation. A questionnaire circulated recently among seventy-six German orthopaedic surgeons showed that eight only were favorable to the method, thirty-eight used it very seldom and only in carefully selected cases, while thirteen declared themselves as distinct opponents, and seventeen remained indifferent.

The American orthopaedic surgeons are much more receptive to the merit of the operative method, although even in this country great differences prevail regarding indications and therapeutic effect. Sorrel, who has an unusual wealth of material at his disposal, states that only three out of 802 children were operated on. On the other hand, 300 out of his 703 adult cases were subjected to the operation. Even Putti remains critical of the operation; he uses it rarely and only in adults, while Galeazzi has completely rejected the operative method.

The object of this article is to contribute from the material of the Hospital for Joint Diseases an analysis of cases of tuberculous spondylitis in children, treated both conservatively and operatively. The sixty-bed Country Home at the seashore, twenty-five miles from the city, offered a splendid opportunity for combining non-surgical and surgical care and for observation of cases during long intervals. In the selection of the material and its assignment to one or the other group, an endeavor was made to provide the greatest possible similarity of skeletal lesions and localization, as well as of the age of the patient, both for the conservatively and for the surgically treated cases. Because of these restrictions in the selection of the cases, which is materially accentuated by the great variability of the syndrome and the very strong individual differences, only a limited number of cases can be reported. On the other hand, the seclusion of the Country Home afforded the advantage of a thorough and fairly long continued investigation. We have, therefore, omitted all cases, both juvenile and adult, which had received only ambulatory conservative treatment, particularly since, according to prevailing use, such treatment is considered as merely a palliative measure which is necessitated by social conditions. The value of this institutional general treatment of bone tuberculosis, as carried out in a country home or sanatorium is already too firmly established to be discussed; although it may be that in individual cases, especially in children, a good result may

* Received for publication August 10, 1932.

be obtained by ambulatory treatment alone. But this is certainly an exception and, in the light of the prevailing and accepted principle, it is far from being the ideal treatment of skeletal tuberculosis.

Taking in consideration first the question of mortality, we find that the statistics of Hibbs and Risser upon 286 cases, which were almost all subjected to early operation, give the mortality rate of twenty-six and two-tenths per cent. during a period of observation covering five years or more. All the deaths were due to disease and not to operation.

In a smaller series of cases of Janik (Clinic of Lwów, Lemberg), covering eight years, from 1920 to 1928, a mortality of thirty-one per cent. in operated cases was found.

Upon first glance, this seems to exceed the mortality rate given by the best known adherents of conservative methods (Kisch, Rollier, and others). However, it should be taken into consideration that their statistics are based merely upon the condition of the patient upon discharge or while still an inmate of the institution.

If we calculate the mortality figures of conservative treatment on the basis of the long observation which was applied for the operative cases, we find that the mortality of operated cases is not so far below that of cases treated conservatively. A close comparison of these mortality figures then will show that the Hibbs or Albee spinal fusions are not representing any specific therapy for spinal tuberculosis; they claim a still higher percentage of victims than do the conservative methods.

It is far more difficult to pass judgment upon the question of biological cure, particularly upon the basis of statistics alone. The five-year interval of observation is not a sufficient criterion for proclaiming an absolute clinical cure and cases of recurrence after many years are by no means uncommon. Therefore, instead of drawing in for comparison the percentages of cures as found in statistics of conservative treatment, it seems to us more reliable to use our own cases as a basis for comparative statistics.

Eliminating all cases which had only a transitory stay at the Hospital or the Country Home and consequently no sufficient treatment or observation, there remain for the purpose of our investigation forty juvenile cases.

Of these forty cases, twelve were treated purely conservatively and twenty-eight were operated upon.

Of the twelve conservatively treated cases, five died and seven are still under treatment at the Country Home. None of these seven has as yet been discharged as cured. This apparent discrepancy in the comparison of the material is explained by the fact that the greater part of the conservatively treated cases at the Home are ultimately being transferred to the surgical group. Their average stay at the Country Home is three years.

The clinical condition of these seven cases is as follows: Two are in very good condition, showing roentgenographically good bony union in the destroyed vertebrae and relatively slight gibbosity. These cases can be

considered as healed, both from the clinical and roentgenographic points of view.

Five cases are in good condition, showing a clinical manifestation of healing. In the x-ray, however, there is no solid union in the vertebral débris. Of these patients, two are up and about in a plaster jacket; while one, with a dorsal lesion, is recumbent in a Calot jacket; and two cases are on frame with traction. We believe that the prognosis is favorable for all these cases, even though four of them show a marked gibbus.

These seven cases demonstrate, in spite of their small number, that it is possible that Pott's disease may be healed in childhood under entirely conservative measures. They also demonstrate that if more than one vertebra is attacked, which is very often the case, a very long time is consumed to effect complete healing. In all of these cases more than one vertebra was involved; in one case with a dorsal lesion, five vertebrae. Even with early and proper treatment and in the absence of sinus formation, one must figure on an average of at least four years of conservative treatment. The question, of course, arises whether it is possible to keep a child in an institution for that length of time, or whether it is not possible to release these cases from institutional care at least for a considerable period of their disease. When we follow carefully the course of the seven cases mentioned, as well as that of the cases operated on after a long period of conservative treatment, the impression is gained that spondylitis remains stationary for a long period of the disease. That occurs when maximum bone destruction has taken place and obvious signs of healing appear in the x-ray picture; in other words, the bone structure becomes more clearly and better defined. At this period new bone is formed, but this process is very slow and the complete formation of the blocking piece of bone, which occupies the site of the destroyed vertebrae, requires years. Apparently hospitalization, even in the best institutions, is not able to effect this, and it is argued that some cases, after a long drawn-out rest, require a change in surroundings in order to bring about final healing at the same rate of progress as observed during the more active stage of the disease. Whereas, in the more active stage, the predominant signs of the exudative type of spondylitis gradually are seen to yield to the productive type (as already described by the writer in a former publication from the Istituto Rizzoli); afterwards, the process of healing seems to remain at a dead level. For such cases, provided they are not complicated by cord compression, an interruption of the rest cure by application of a plaster-of-Paris cast and tentative discharge from the institution may be beneficial. Putti and Vacchelli reporting from the Alpine Sanatorium of Cortina di Ampezzo, emphasize this fact, and insist upon patients being removed from the institution from time to time, and advocate particularly the change from Alpine to maritime surroundings.

It was mentioned that four out of the seven cases treated conservatively showed marked deformity. This also applies to some of the surgical cases which had been treated on a frame before operation and

which showed a considerable increase in the kyphosis. In all of these cases attempted corrections of the deformity were uniformly unsuccessful with the exception of a single case which was treated on the frame with felt padding under the gibbosity. In this latter case the tracing of the deformity showed unmistakable though not very considerable correction of the angulation. This fact is emphasized because it proves that correction of spondylitic gibbus is indeed possible in recumbency. Finck has treated a large number of cases in which the gibbosity was successfully improved or entirely corrected by this method of gradually increasing pressure by means of cotton padding placed under the deformity in the reclination bed of Lorenz. Waldenström also, making use of the same method, gives some striking results of correction of the deformity or improvement in eighty per cent. of the cases. Finck takes his idea from the Calot method of redressment force of the spine; although he does not actually use this method, the principle of which has met with serious objections from all sides. As a matter of fact, it seems that the correction is more apparent than real, inasmuch as the process observed in the spine, in response to the slowly increasing pressure, develops compensatory curves above and below the diseased area, to which may be added the atrophy of the prominent vertebral processes.

We must say one word in regard to the five fatal cases in our series of twelve conservatively treated. This may, at first, be a strikingly high figure, but it becomes readily understandable if we consider that these cases, because of their poor general condition, were not taken into the group of surgical cases. Two of these latter cases showed double lesions,—that is, a spondylitis and fungus of the foot with cold abscess and sinuses; and a spondylitis with caries of the frontal bone. These patients also had pulmonary tuberculosis. In three other cases there were abscesses with amyloidosis and general sepsis; one of these showed a paralysis of the lower extremity, the other a severe degree of ascites due to general amyloidosis and weakness of the heart. Cases with double lesions took a very malignant course from the onset.

OPERATIVE GROUP

The operative group may be divided into two groups: those operated on early,—that is, those in whom the spinal fusion was carried out in the first year of the disease; and those operated on late,—that is, those in whom the spondylitis existed clinically for at least one year and the operation had been preceded by conservative measures.

The first group embraces nine cases; the second group nineteen. This ratio clearly indicates that the policy of the Hospital for Joint Diseases is to treat children with Pott's disease conservatively at first; the surgical steps follow upon the completion of the conservative treatment.

In regard to the age, the patients operated upon early varied from three to thirteen years,—average, six years of age. All but one remaining

in the Country Home had conservative after-treatment for a period ranging from one to eight years.

Of these cases operated on early, two died; one, one year and the other four years after operation.

It seems that the operation can not be brought into a causal relationship with the fatal issue, and we must consider the operation as almost absolutely safe. One of these two patients died of amyloidosis of the viscera after the postoperative appearance of numerous abscesses and sinuses; in the other case the operative field became infected with tuberculosis, the graft became necrotic, partially extruded, and death ensued as the result of miliary tuberculosis.

A survey of the results in the remaining cases operated on early was as follows:

In one case the result was excellent. In this case, however, we believe that the prompt cure was independent of the operation and that it was due to the rather infrequent fact that only one vertebra was attacked. Of this, only half of the vertebra was destroyed and the adjacent intervertebral disc was not involved. Healing took place without deformity and with complete normal function of the vertebral column, as a control examination showed six years after the operation. At that time, the graft had completely disappeared.

The remaining six cases, following operation, showed a considerable increase of the deformity as a result of further destruction of the vertebrae, with the exception of two cases in which too short a period has elapsed to make a reliable statement in this regard. In one case there appeared paralytic manifestations of the lower extremity, of the bladder, and of the rectum immediately after the operation, which persisted for two and one-half years, in spite of the fact that the patient was lying comfortably on a frame with both of his legs in traction. In another case the bone graft turned out to be too short because of subsequent expansion of the caries, so that a second Albee operation had to be performed to fix the whole diseased spine.

Summarizing these nine cases operated on early, the impression was that the Albee operation performed early in the disease is not likely to shorten the course of the disease or to lessen its severity. It seems that the spinal tuberculosis of childhood will, in spite of operation, pursue its course, and that it sometimes will extend beyond the section of the spine which had been fused. The graft in the still active vertebral process is altogether unable to prevent the appearance or the increase in deformity after operation. It would seem, therefore, that, since sufficient immobilization can be obtained by means of the frame or the plaster bed, there is no reason for undertaking the operation in the early stage of Pott's disease.

LATE CASES

It now remains to consider these conclusions with reference to the two groups of cases which were operated on late. This series comprises nine-

teen cases, from four to sixteen years of age. The operation was carried out on an average of four years after the onset of illness. Nine of these operations were performed after a more or less continuous conservative treatment in other institutions. The remaining ten cases entered the institution while the process was still active and remained there for a period of from eight months to three years, on an average of two years before operation was performed. All cases were sent back to the Country Home for after-treatment. Three of the ten are about to be discharged, while the other seven have remained from eight months to two and one-half years—an average of sixteen months—after the operation. Therefore, of the nineteen cases operated on late, twelve cases have been discharged and seven are still at the Home. Of these remaining seven cases, one is in utterly hopeless condition because of complete paralysis and extreme deformity, both existing before the operation. Two show very good results, while the four others are still too recent to be classified.

The results of the twelve cases which have already been discharged can be classified as altogether good. In seven cases, cure was effected with little or no deformity and the result was excellent. In six of these, the lesion was in the lumbar spine. Of the five remaining, four show considerable kyphosis; three of them are still wearing a light corset. The whole period of postoperative observation varies from two to six and one-half years,—an average of three years.

The data regarding duration of conservative preoperative and postoperative treatment in surgical cases show that the operation is to be considered only as a link in the chain of various measures and has, in the whole plan of treatment, essentially no greater importance than the associated procedures.

We have already mentioned the fact that in our early cases the graft was unable to hinder the appearance or the future development of the deformity, and that even in three of the cases operated on late there was a postoperative increase of the deformity, though a slight one. We may say, therefore, that the graft does not represent a purely mechanical support of the vertebral column with the action of a ramrod, which was attributed to it by the original conception (due to the influence of Lange's idea of using celluloid staves). Mention is made of this because this view is still altogether too prominent.

On the contrary, the bony tissue undergoes a continuous rebuilding as it does in other bone transplants in the body. The graft dies almost entirely and is slowly being absorbed and replaced by new bone tissue upon which mechanic and static factors subsequently become operative. According to the writings of Dubois pressure is of far greater significance for the maintenance of the bony structures than tension, and the latter rather tends to promote absorption if in excess of a certain physiological maximum. In the x-ray picture, consequently, we see areas of clarification, sometimes even as transverse fissures, and this lack of continuity is often mistaken for fractures. They represent essentially the same forma-

tions as are sometimes observed in extra-articular arthrodesis of the hip, especially when this operation has been performed in too early a stage so that joint destruction with adduction deformity takes place. In fusion of the hip joint, for instance, the bone graft, if placed at early stages of the disease, is unable to prevent the appearance of the adduction deformity, and the tension continually exerted upon the graft by the contracting capsule and muscles on the inner side of the joint brings about a pseudarthrosis in this area of resorption (*Umbauzone*). The bone graft in operations upon the spine is still considerably weaker than the graft used for arthrodesis of the hip, and therefore much less able to prevent deformity by its own strength. The earlier the operation is carried out in a case of destructive spondylitis, the less is the possibility of preventing the deformity, since the continuing vertebral caries leading to a mutual approach of healthy bone processes after collapse of the necrotic area, in combination with the contractures of the anterior vertebral structure, subject the graft to forces of tension of an unphysiological degree, such as living and extremely plastic bone is not able to resist. So we see the tissue becoming absorbed at the point of the severest tensile stress and zones of osteoblastic activity develop known as "Looser's *Umbauzonen*" with formation of a pseudarthrosis. This usually lies directly over the gibbus at the transition point between the diseased, relatively less movable, and the healthy, comparatively more movable section of the vertebral column. In our material of fifteen cases these zones of clarification could be clearly seen, and, therefore, we feel that the fear expressed by some authors, that the bone graft might interfere with the collapse of the destroyed vertebrae and the subsequent solidification usually necessary to produce satisfactory healing of tuberculous spondylitis, is without grounds.

Conversely, it has been maintained that, if the deformity can increase after operation, the graft is useless as a support for immobilization of the diseased spine. It seems that in the decision on this point lies the whole basis for the indication of operative stabilization of the spine in tuberculosis.

As already mentioned, the circumscribed areas of absorption, forming a pseudarthrosis, are known as "*Umbauzonen*". We find that this area is composed of connective tissue, often with cartilage and calcium-free or osteoid bone. It is strong enough to bring about sufficient immobilization of the diseased part of the spine for practical and clinical purposes and it represents much better fixation than a corset. When we reoperate on these cases, as is frequently done, we see that, in spite of the lack of calcified bone tissue, the spinous processes are firmly fixed to each other, while those above and below the operative field are freely movable. We, therefore, believe that the argument that zones of rarefaction will appear, particularly in the neighborhood of the graft, is not a sufficient reason to doubt the validity of the bone graft. On the other hand, we see that in the graft itself physiological changes of bone structure occur, ending in

the complete and permanent resorption of the transplanted graft which has been observed in two of our cases with perfect functional result. We might feel, therefore, that in cases of slight involvement of the vertebrae, in which the intervertebral disc is not involved, the function of the graft would be doubtful. Experiments of Walter Müller seem to prove that no normal joint could be successfully fixed by bone graft, placed extra-articularly. It is from this point of view that we might find an argument against Albee's method in mild tuberculous caries, as this is entirely an extra-articular method.

In cases of dorsal Pott's disease, the graft often undergoes such changes that a mere narrow strip of bone remains, binding together the tips of the spinous processes and corresponding exactly to the ossification of the supraspinatus ligament. In the lumbar spine, on the contrary, there is often found at the conclusion of the rebuilding an obvious increase in the thickness of the transplant, palpable even through the skin as a large bony mass. It seems, therefore, that the lumbar region appears more suitable for the Albee operation than the dorsal region. The graft here evidently is subjected to a greater functional demand under the influence of which it hypertrophies. Absorption at the border of the lumbosacral region, however, seems to be the rule. This, too, shows how greatly dependent the graft is upon the movability of the neighboring joints, which is certainly greater in the lumbosacral articulation than in the intervertebral joints of the spine above. On these grounds, it seems that the Hibbs method of spinal fusion with operative destruction of the small joints of the vertebrae, if exactly carried out, would be superior to the Albee technique.

In conclusion, we would like to mention a series of postoperative complications. Here belong the appearance of psoas abscesses, sinuses, and paralysis, so often encountered following the operation, especially when it has been carried out in the early stage. These are naturally not referable to the operation itself and merely show that spondylitis in these cases follows its natural course unhindered by the operation. The later the operation is performed,—that is, the farther the vertebral disease is on the way to healing, the rarer are these complications.

Of greater importance is the appearance of abscesses and sinuses in the operative field, as occurred in three of our cases.

It is also worth mentioning that among our twenty-eight cases operated upon there were four postoperative fractures of the tibia at the site of the removal of the graft. In three cases the fracture developed upon the operating table during the removal of the graft, and in one case ten months later after a slight trauma. In three cases the fracture healed perfectly without complications; however, in one case there was a double fracture which led to pseudarthrosis for which a new operation with transplantation of a bone graft from the other tibia was necessary.

The most serious complication was the sudden appearance of postoperative paralytic ileus in a case of lumbar spondylitis. Here, ileostomy

had to be performed and the patient ultimately recovered. In this case also it was found that the cerebrospinal fluid, recovered during the lumbar anaesthesia at the time of the ileus operation, was positive in the guinea pig for tuberculosis. This shows that an external pachymeningitis may be associated with spondylitis, and tubercle bacilli may appear in the fluid without any clinical signs of tuberculous meningitis.

CONCLUSIONS

The most important results of this investigation may be summarized as follows: Pott's disease in childhood is very well capable of healing under purely conservative measures. The average duration of the healing process in a sanatorium is at least four years. The Albee operation, when undertaken in an early stage, is unable to protect the vertebral column against deformity. With increasing destruction of the vertebrae, the tibial graft undergoes marked changes with circumscribed resorption, usually immediately over the gibbus. Being plastic bone tissue, it is bent out of shape. It, therefore, appears useless to undertake the operation upon children in the early stage. The facts that at this time it is impossible by the means of the roentgenograms to say anything definite regarding the extension of the vertebral tuberculosis, and that at the time of operation vertebrae which appear roentgenographically normal and which are not included in the region of fusion may be diseased, these facts, likewise, speak against operation in the early stage.

In the late cases in which the spondylitis is already on the way to healing or is already healed as a result of conservative measures, the problem is different. In such cases, the graft may contribute considerably to the stabilization of the defective spine, especial y in the lumbar region, and to the assurance of maintaining the result already reached. Following the necrotic process, subluxations in the intervertebral joints certainly result from the dislocation of the body fragments. This, no doubt, leads to seriously altered statics in the whole vertebral column and to manifestations of insufficiency of the muscular and ligamentous apparatus with pain. We must admit, however, that the juvenile organism is able to adjust itself to even a very severe deformity over a very long period of time. Ultimately, however, increasing manifestations of fatigue appear. These are often interpreted as indications of recurrence of the tuberculous inflammation, whereas they are as a matter of fact merely signs of static insufficiency. In such cases, operation seems to be indicated. It is in these cases, however, merely symptomatic and not directed against the disease itself. Our material, although rather limited, seems to indicate that, even before the onset of static insufficiency of the spine, the spinal fusion may be effective immediately after the conclusion of conservative treatment. It is perhaps, as a new stimulus, capable of forcing the organism into the last stage of healing, which is usually somewhat protracted, and so of bringing about somewhat more rapidly bony union of the vertebral

fragments. The observations of Waldenström and Johansson seem to point in this same direction.

The writer wishes to acknowledge his gratitude for the generous permission to use the material of the Hospital for Joint Diseases.

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RESTORATION OF THE DIGITAL PORTION OF A FLEXOR TENDON AND SHEATH IN THE HAND

BY MATHER CLEVELAND, M.D., NEW YORK, N. Y.

The difficulty of restoring a lost flexor tendon in a finger is well recognized by every surgeon who has attempted it. For success in plastic surgery of this type certain conditions are requisite. The skin and subcutaneous tissue of the finger should be in good condition, freely movable, not bound by adherent scar to the phalanges. Starting at this point the surgeon must introduce a new tendon with an adequate gliding mechanism and restraining band or vinculum at the joints to keep the tendon from bow-stringing. Primary union and early, carefully controlled, active motion are essential to regain function. In my experience a great majority of the patients who have lost a tendon in a finger have stiff fingers with adherent scars, and failure or only partial success has attended any surgical attempt to restore the tendon.

In March, 1931, a girl of eighteen applied at the New York Orthopaedic Dispensary, complaining of a deformity of her right middle finger, which followed an infection five years previously. This infection began as a furuncle at the distal flexion crease, which was incised inadequately, and within a few days the entire hand was swollen and acutely painful. She entered a hospital near her home, where a second operation was performed. An incision was made in the proximal closed space and another over the palmar portion of the tendon sheath of the right middle finger. Both of these incisions were in the long axis of the tendon sheath. The wounds drained for about two weeks and no sloughing of the tendons occurred. Since the operation there has been complete inability to flex the finger.

Physical examination showed no active flexion in the proximal or distal interphalangeal joints of the right middle finger, but free passive motion. The middle phalanx was pulled into hyperextension by the lumbricalis and interossei. This deformity was most distressing to the patient and made her reluctant to shake hands. The skin and subcutaneous tissue were in good condition. It was impossible to determine whether the tendons had been divided and retracted, or destroyed by infection, but it was decided that a repair should be attempted.

Operation June 16, 1930, Case 127,361, New York Orthopaedic Hospital. Under a blood-pressure-cuff tourniquet, released at thirty-minute intervals, a transverse incision was made in the distal flexion crease of the right middle finger toward the ulnar border of the finger, then continued anterolaterally to the proximal flexion crease, then transversely along this crease to the middle of the finger and proximally into the palm. This single incision exposed the entire digital portion of the finger and the adjacent palm. The profundus tendon insertion remained as a tiny stump, about one and five-tenths centimeters long, attached to the distal phalanx. Proximal to this no tendon or sheath could be seen until the middle of the palm was reached, and there the proximal ends of the flexor sublimis and profundus tendons were found bound down by scar tissue. The sublimis tendon and a delicate sheath surrounding it were freed and excised, making a free graft eight to ten centimeters long (Fig. 1). This was sutured to the distal and proximal stumps of the flexor digitorum profundus (Fig. 2). A strip of fascia lata was excised from the thigh and folded around the reconstructed tendon with its gliding or smooth surface adjacent to the tendon. At each of the joints a small strip of fascia lata

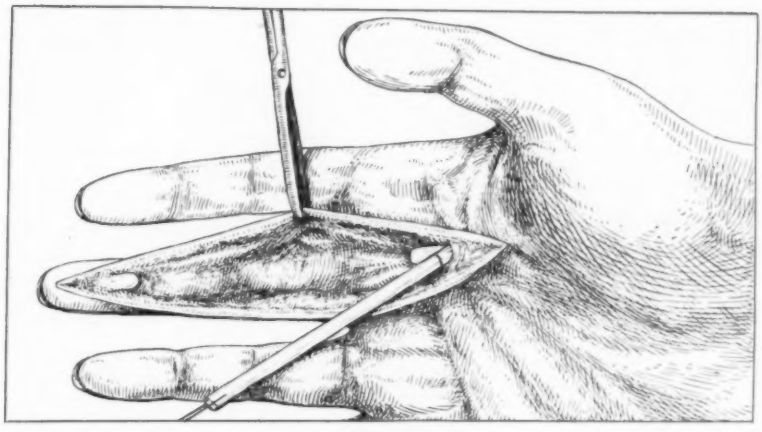

FIG. 1

Shows the exposure of the finger and palm, with the stump of the profundus tendon attached to the distal phalanx. The sublimis tendon has been freed in the palm and is drawn out into the wound and divided to form the free tendon graft. (The skin incision in the drawings is schematic.)

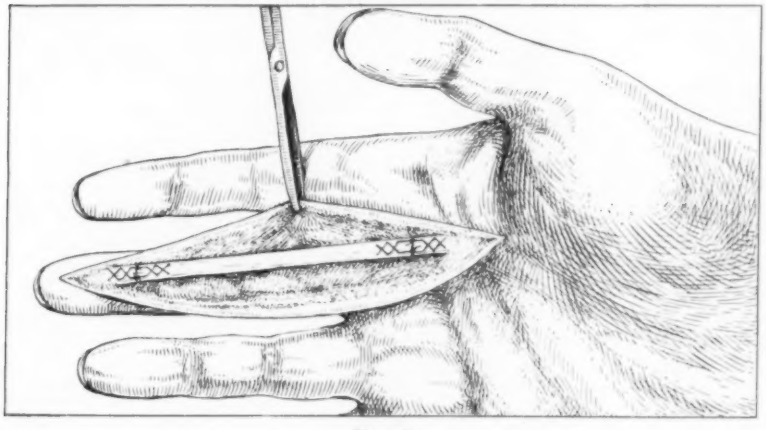

FIG. 2

Shows the sublimis tendon graft sutured to the distal and proximal profundus tendon stumps.

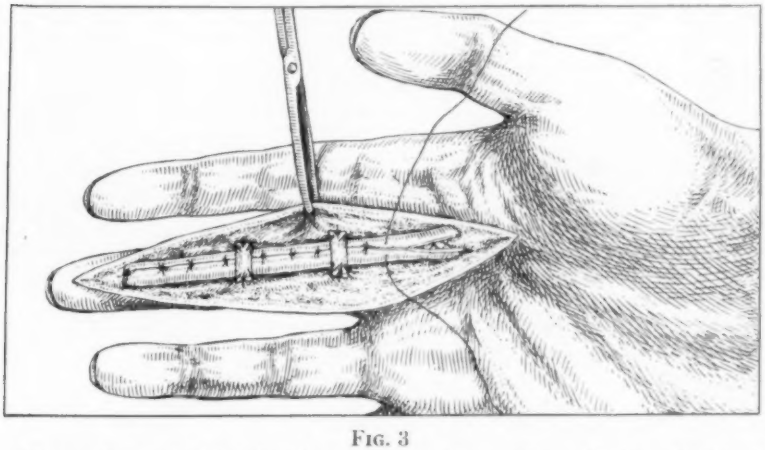

FIG. 3

Shows the fascia lata sheath around the new tendon with the vincula of fascia lata at the proximal interphalangeal and the metacarpophalangeal joints.

FIG. 4
Shows end result two and a half years after operation.

was drawn over the tendon and its sheath and sutured to the periosteum and scar tissue on each side. The strips were intended to serve as vincula (Fig. 3). Fine interrupted silk sutures were used throughout. The subcutaneous tissues were closed with plain catgut, and skin with dermal, all interrupted. The finger was held in flexion with an elastic band and the patient was instructed to extend the finger actively against this elastic pull, beginning the first postoperative day. She left the hospital on the twelfth day after operation with her wounds healed and a fair range of motion in the finger.

Apparently the tendons had been divided in the previous operative procedure and the sheath had been obliterated by the infection.

At the most recent examination, December 27, 1932, two and one-half years after operation, the patient was found to have a useful hand and finger. She is delighted with the result which is shown by the photographs taken on this date. The right middle finger is held flexed twenty degrees at the proximal interphalangeal joint and forty degrees at the distal interphalangeal joint. Active motion in the various joints of the finger is present as follows:

Metacarpophalangeal joint:	
Extension to 180 degrees Flexion to 90 degrees	Full range
Proximal interphalangeal joint:	
Extension to 160 degrees Flexion to 90 degrees	Lacking 20 degrees of the full range. Seventy-seven per cent. complete.
Distal interphalangeal joint:	
Extension to 140 degrees Flexion to 120 degrees	Only 20 degrees of motion or about thirty per cent. of average total.

There is a very slight tendency for the tendon to bow-string from the metacarpophalangeal joint to the distal interphalangeal joint.

The large measure of success in this procedure was probably due to the following factors which are sufficiently important to repeat:

1. The excellent condition of the skin and subcutaneous tissue.
2. The free motion in the interphalangeal joints.
3. The introduction of an adequate gliding mechanism around the new tendon.
4. The placing of vincula at the interphalangeal joints to prevent bow-stringing.
5. Early active motion.

OS SUBTIBIALE

Inconstant Bone Over the Tip of the Medial Malleolus *

BY PAUL W. LAPIDUS, M.D., NEW YORK, N. Y.

Assistant Adjunct, Hospital for Joint Diseases;
Assistant Surgeon, Hospital for Ruptured and Crippled

The very unusual findings and the extreme rarity of the condition observed in the cases reported below make it worthy of a permanent record in print.

Case 1. L. P. (C-3357), white, a plumber, twenty-three years of age, was seen by the writer in the Foot Department of the Hospital for Joint Diseases on February 27, 1931. The patient complained of pain over the right medial malleolus, following a sprain about three months previous to the admission. He also gave history of spraining the right ankle in eversion about eight years ago (at the age of fifteen). After the first injury there was swelling and ecchymosis around the right medial malleolus. The patient remained in bed during the first day and walked with a slight limp for a few days thereafter. Following that he had no discomfort, but noticed that his right medial malleolus gradually became more prominent than the left.

Examination revealed that the patient was a young man in apparently good general health. There was moderate outward bowing of both tibiae with marked compensatory pronation of both feet (Fig. 2). The forefeet were slightly abducted, with longitudinal arches fairly well preserved. The right medial malleolus (Fig. 1) appeared unusually prominent, but it was not at all tender. Motion in all joints of the feet was perfectly free and painless, and the pulsation of the feet arteries was good.

The roentgenogram of the right ankle (Fig. 3) was reported by Dr. M. Pomeranz as "Ununited epiphysis—internal malleolus, right ankle".

A tentative diagnosis of ununited epiphyseal separation of an inconstant epiphysis of the medial malleolus was made.

The roentgenogram of the opposite ankle, taken at a later date, also showed the presence of a similar ossicle, symmetrically located over the tip of the left medial malleolus (Fig. 3). This ossicle, however, was much smaller than the one on the right side, and it showed less calcification. The right ossicle measured twenty by nine millimeters; the left, twelve by six millimeters. Each was connected with the medial malleolus along its longer dimension in oblique plane to the long axis of the tibia. The right medial malleolus correspondingly was much wider than the left, the right measuring twenty-one millimeters and the left twelve millimeters.

The patient was admitted to the hospital and the prominent part of the right medial malleolus was removed.

The specimen was reported by Dr. H. Jaffe as consisting of "a small fragment of bone showing nothing unusual on macroscopic examination. Sections showed two fragments of rather compact bone separated by fiber bone containing numerous Sharpey fibers."

It is evident that we had in the above described patient a case of rare variation of ankle skeleton where the trauma had caused slight changes on the right side and certainly could not be considered an etiological factor.

Case 2. M. W. (C-72-872), a white boy, nine years old, was seen in the clinic of Dr. Toufick Nicola at the Hospital for Ruptured and Crippled on March 25, 1933. The boy

* From the service of Dr. Leo Mayer, Hospital for Joint Diseases, and Dr. Percy W. Roberts, Hospital for Ruptured and Crippled.

complained of occasional pain in the right leg for the past few months. There was no history of injury to feet or legs. The child was somewhat overweight showing evidence of endocrine disturbance. There was slight enlargement over the anterior plane of the right tibia. He also presented a moderate degree of weak feet. The medial malleoli were not unusually prominent and were not tender. The roentgenograms of the right leg showed an old cortical abscess of the tibia. Incidentally a small ossicle was found beneath the tip of the right medial malleolus. A check-up roentgenogram of the left ankle revealed a similar ossicle beneath the left medial malleolus (Fig. 4).

FIG. 1

Case 1. Close view of the right foot before the operation. Note considerable pronation and very marked prominence of the medial malleolus.

The writer is under the impression that Case 2 also presented a separate os subtibiale. However definite differentiation from an accessory center of ossification in the tip of the medial malleolus will be possible only in the future, providing the ossicle still remains separate by the time of disappearance of the lower tibial epiphysis.

FIG. 2

Case 1. Appearance of both legs and feet (after the operation). Moderate outward bowing of legs with compensatory pronation of feet. Note the still present prominence of the right medial malleolus (arrow).

A review of the literature on the subject shows only a few reports of a similar condition. Pfitzner and later Bircher described this ossicle under the name of "Os Subtibiale".

Fairbank quotes Sir Arthur Keith, admitting that the latter had never met with a case and was unable to offer any morphological explanation of the condition.

Neither Holland nor Lupo, in his study of inconstant bones of feet, has ever seen a case.

Mouchet reported one case which he considered "curious" and stated that he had never found any mention of this condition in treatises of anatomy. However, Gray, describing the development of the tibia, stated that "two additional centers occasionally exist,—one for the tongue-shaped process of the upper epiphysis, which forms the tubercle, and one for the inner malleolus". Gray also said in his description of sesamoids that "sometimes sesamoids are present over the medial and lateral malleoli".

Åkerlund does not say anything about a special center of ossification

FIG. 3

Case 1. Anteroposterior view of both ankles showing bilaterally present os subtibiale. Note that the right os subtibiale is larger than the left and is more calcified. The right medial malleolus is correspondingly wider than the left.

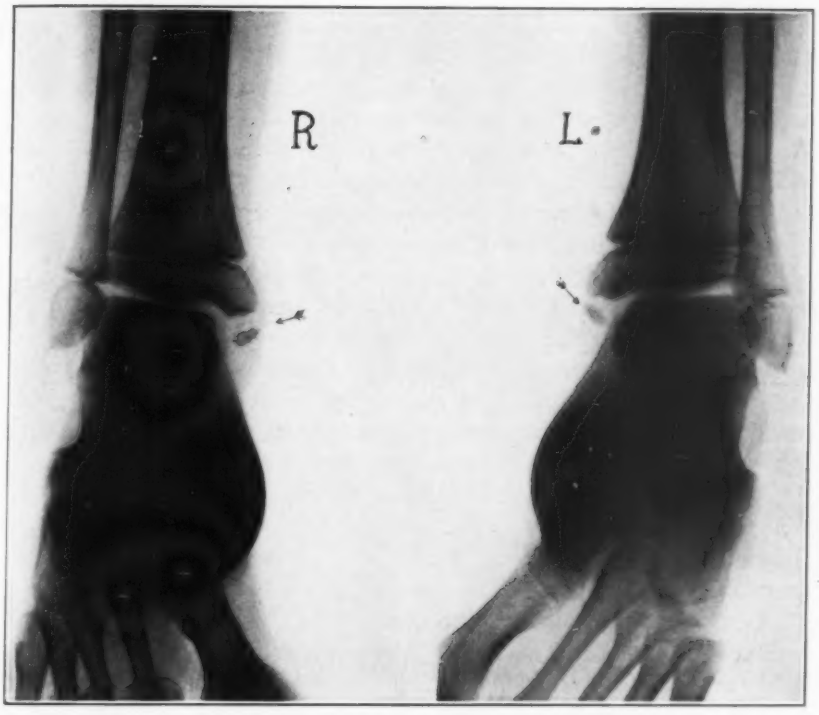

FIG. 4

Case 2. Bilaterally present separate ossicle (arrow) in the tip of medial malleolus.

for the medial malleolus. However, his Table I, Figure 2, shows a roentgenogram of a foot in the case of a girl, eight years old, where this center is demonstrated.

In our previous report (Burman and Lapidus) of a study of 1000 feet (mostly in adults) with special reference to inconstant bones, we did not observe a single case. However, only dorsiplantar and lateral views of feet were studied, while os subtibiale is most clearly seen on anteroposterior views of the ankle, the latter not being included in our series.

On the other hand, Den Hoed in a review of roentgenograms of 150 sound children between the ages of six and fifteen, found in twenty-one cases (fourteen boys and seven girls) a separate center of ossification for the tip of the medial malleolus. Den Hoed did not examine both feet and does not know whether the condition was bilateral. He does not think it is as rare as considered by Fairbank.

It is the author's conclusion, from the analysis of previously reported cases, that there are two definite entities, which have not as yet been clearly differentiated. That might have accounted for the contradictory opinions regarding the frequency of this condition.

The first group may be classified as an inconstant center of ossification or, possibly, an epiphysis of the medial malleolus somewhat similar to the one observed over the styloid of the fifth metatarsal. The cases of

Fairbank, Den Hoed, and Mouchet, all observed in children, seem to fall in this group.

Mouchet's case of a boy twelve years old is especially illustrative. Taking three consecutive roentgenograms at six months' intervals, Mouchet found on the second roentgenogram the center of ossification over the tip of the medial malleolus considerably larger than on the first; the third roentgenogram showed complete fusion of the center with the medial malleolus. Den Hoed found the center of ossification of the medial malleolus most commonly present between eight and nine years, at which age the center of ossification was also of the largest size.

The second group of cases, all observed in adults, as Bircher's cases and the author's Case 1, are best fitted into classification of an inconstant bone,—"os subtibiale". These cases are no doubt extremely rare. Accessory scaphoid, os trigonum, or accessory center of ossification of the adult patella, may be considered homologous with os subtibiale. The only definite confirmation of this point of view, considering os subtibiale as an inconstant bone, would be the discovery of an independent bone similarly located at the tip of the medial malleolus in some lower animals. This problem is beyond the scope of the present paper, and its solution is left to those better qualified to answer it.

Ruckensteiner demonstrated the presence of the distal tibial epiphysis as early as the seventh month of life, in any event nearly always before the second year. According to him, the distal tibial epiphysis develops in transverse direction to the long axis of the limb. As the ossification of this epiphysis reaches the medial lower edge of the tibial diaphysis, the ossification of the epiphysis continues medialward and downward, forming the medial malleolus. The latter takes place only at the age of eight or nine years. At about this time an inconstant independent center of ossification may occasionally be formed at the tip of the medial malleolus. This center seems to unite soon after its appearance. One case was seen by Ruckensteiner.

Whether the cases of accessory center of ossification of the medial malleolus and the case of os subtibiale are two entirely independent conditions, or related in the respect that os subtibiale is just an accessory center which failed to fuse to the medial malleolus, remains a moot question.

Gray's and Grashey's interpretation of os subtibiale as a sesamoid is mentioned only to be discarded. The writer agrees entirely with Lupo, Fairbank, and those to whom Fairbank showed his roentgenograms, that a diagnosis of sesamoid is out of the question.

The generally accepted conception of a sesamoid as a bone imbedded in a tendon running over a joint between two other bones, and having an articular facet covered with hyaline cartilage facing the joint cavity (as the patella), certainly does not agree with the features of the os subtibiale nor the accessory center of ossification of the medial malleolus.

SUMMARY

Two cases of bilateral extremely rare inconstant bone, os subtibiale, are reported,—one in an adult, the other in a child.

An accessory center of ossification over the tip of the medial malleolus is occasionally observed in children, appearing around six and fusing at about thirteen years of age. This accessory center and the os subtibiale seem to be two different entities which, however, may have some relation to each other.

The writer is greatly indebted to Dr. T. Nicola for his kind permission to report Case 2, and also to Dr. R. Lewis, the Roentgenologist of the Hospital for Ruptured and Crippled, for bringing to the author's attention the very interesting roentgenogram.

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TUBERCULOSIS AND POLIOMYELITIS *

BY DR. E. ŘUMSHINA, KHARKOV, U. S. S. R.

From the Clinic of Orthopaedic Surgery and Traumatology, Kharkov Medical Institute, Prof. S. L. Tregubow, Director

According to statistics of orthopaedic institutions in Europe, the largest percentage of disease is that of bone and joint tuberculosis, and the second that of deformity resulting from anterior poliomyelitis. Both of these diseases are met with chiefly in early childhood, and it would be expected, considering the very large number of cases, that some would be found in which these diseases are associated. However, no mention of such a relation of conditions has been found in the Russian literature and only one reference in any foreign literature.[1] Recently an article was published by a Swiss physician, requesting information as to whether any observer had ever seen the combination of bone and joint tuberculosis and infantile paralysis. Such a case had never come to his attention.

During the twelve years in the Clinic of Orthopaedic Surgery and Traumatology in Kharkov, in which a large number of surgical cases in children have been treated, and through which 4,350 cases of tuberculosis and 1,407 cases of infantile paralysis have passed, there has been observed but one in which there was the undoubted coincidence of tuberculous coxitis and poliomyelitis. The rarity of the case justifies its full report.

The case is that of a boy of fourteen, of healthy parentage, well, and of good physical development, until the age of three, in 1921. Following injury to the left leg, he developed a limp, and four months later, after a repetition of the trauma, there was inability to use the leg. Treatment by a plaster-of-Paris spica was instituted, and, on removing the bandage three months later, the patient was again able to walk, but at this period the child developed an acute illness, with high temperature, and was kept in bed for six weeks, after which there was discovered paralysis of both legs. The right after a time gradually recovered; the left remained flaccid. In 1922, in the vicinity of the left hip joint, a fistula appeared, which healed after five or six months, and remained closed. The use of the right leg gradually returned, but the left has made no improvement up to the present time. A few small ulcers, which healed slowly, appeared on the sole of the left foot; otherwise, the general health of the patient has been good.

Present condition: Patient is somewhat backward in growth for his age,—height, 188 centimeters; weight, 30 kilograms; poorly nourished; has large lymphatic glands and shows, due to the paralysis, a distinct obliquity of the pelvis, lower on the right. The lower extremities show marked atrophy of the muscles of the left leg, eversion of the hip, genu valgum, with foot in equinus. The skin is cyanotic, with atrophic cicatrices from old ulcers; almost entire paralysis of the muscles of the hip and of the leg, with shortening of thirteen centimeters (six in the upper and seven in the lower portion); atrophy of the thigh of seven centimeters, and of the calf of six centimeters. All active movements of the left leg are absent; passive movements free. The hip joint allows motion to ninety degrees, adduction normal, abduction limited, rotation painful. The trochanter is five centimeters above Nelaton's line. The knee joint allows flexion to ninety degrees, and

* Reported at the Scientific Section of Orthopaedic and Traumatic Surgery, March 27, 1932.

full extension. There is motion in the ankle joint,—dorsal flexion to 120 degrees, plantar flexion normal; reflexes are absent.

In the right leg, the most notable changes are in the region of the sole of the foot; foot is in pes calcaneus and cavus; toes in dorsal flexion; general atony of the muscles; reflexes are slow; sensation normal.

The roentgenogram in April 1932 (Fig. 2) showed pathological changes,—an upward dislocation of the hip; the acetabulum widened and deformed; the trochanter major resting on the os ilium; the head of the femur absent; remains of the neck somewhat pointed and extending into the acetabulum; very slight reparative changes. General examination of the urine and blood was practically negative. The von Pirquet reaction was positive; Wassermann negative.

The electric tests for muscles showed complete loss of response to galvanic and faradic currents on the left. The right leg, in tests to electric excitability, showed R-0.8, A-2.5, indicating a small elevation of excitability.

Attention is called to some of the peculiarities of this case,—namely, the absence of contraction in tuberculous coxitis; the marked degree of motion in the joint (passive flexion to ninety degrees): and the extreme degree of shortening of the leg (thirteen centimeters).

The condition evidently indicates a tuberculous coxitis, with marked destructive changes, together with the residuum of an infantile paralysis.

FIG. 1

FIG. 2

It has always been a point of interest that the association of joint tuberculosis and poliomyelitis is so seldom observed. The diagnosis of neglected cases, so often met with, does not present difficulties, and the recognition of these conditions should not be difficult, and errors should not be so frequent as, for instance, with lues of the bone. The explanation of this rarity of occurrence is difficult; it is a question whether those individuals having suffered from poliomyelitis have some biological immunizing properties in regard to tuberculosis, and *vice versa*. Moreover, there arises the question as to why poliomyelitis is not met with in combination with osteomyelitis, also often found in children, but seldom in children who have suffered from poliomyelitis, and who, therefore, having atrophied bones, would seem to be more susceptible to trauma and would give a greater percentage of such hybrid cases. However, such combinations have not been observed by us.

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ISOLATED FRACTURES OF THE OS MAGNUM AND TRAPEZIUM

EARLE I. GREENE, M.D., F.A.C.S., AND LEO FREDERICK MILLER, M.D.,
CHICAGO, ILLINOIS

Fracture of a single carpal bone, with perhaps the scaphoid as an exception, is a condition worthy of recording. It is important to make an early and accurate diagnosis in all lesions of the wrist, for upon this early knowledge of the exact pathology depends often the ultimate condition of the wrist. If, however, more of these injured wrists are given the benefit of a very thorough and critical roentgenographic study, more of these isolated bony fractures will be recognized and appropriate treatment instituted. A review of the literature reveals twenty-four isolated fractures of the os magnum, and but twenty fractures limited to the trapezium.

Fractures of the os magnum may be caused either by direct violence over the bone, or may result from indirect force applied to the head of the second, third, or fourth metacarpal bone of sufficient force to bring about forcible flexion at the wrist joint. Destot [1] and Gallois have succeeded in experimentally producing a decapitation of the neck of the os magnum, but usually a fracture of the posterior lip of the radius resulted.

The trapezium, by its protected position and its ligamentous attachments, is almost immune to fracture. Kindl [2] attempted to produce fractures of the trapezium by beating on the end of the first metacarpal bone with a hammer and was able to secure only one fracture

FIG. 1
Fracture of the trapezium.

FIG. 2
Fracture of the os magnum.

of this bone out of ten fractures produced in the thumb and noted that in order to produce a fracture of the trapezium, the thumb must be abducted and its metacarpal bone rigidly flexed.

Fracture of the os magnum and trapezium may occur as a result of direct or indirect trauma, the latter being by far the more common. Although any of the carpal bones may be broken by direct injury, as by a severe crushing wound, such fractures usually involve multiple carpal bones with considerable crushing of the soft parts. Indirect violence, resulting in an isolated carpal bone fracture, is the more common mechanism, coming usually from a fall on the hand.

In os magnum fractures, swelling, especially on the dorsum of the hand, may be considerable, with tenderness localized over the involved bone. At times the pain may radiate to the fingers, following the course of the median nerve. Crepitus is seldom elicited. In fractures of the trapezium, swelling and pain on the radial side of the wrist at the base of the thumb may be pronounced, with pain on motion of the thumb.

Treatment in fractures of the os magnum consists of complete immobilization of the hand in straight extension for four weeks. These fractures all tend to heal by bony union and, although there is prolonged swelling and pain, the prognosis is good. Excision of the os magnum is necessary for dislocated fragments or persistent symptoms of pain, stiffness, or great loss of function.

In fractures of the trapezium, immobilization of the thumb and wrist, with the thumb placed in slight abduction and at an angle of forty-five degrees to the carpus, is necessary for eight weeks.

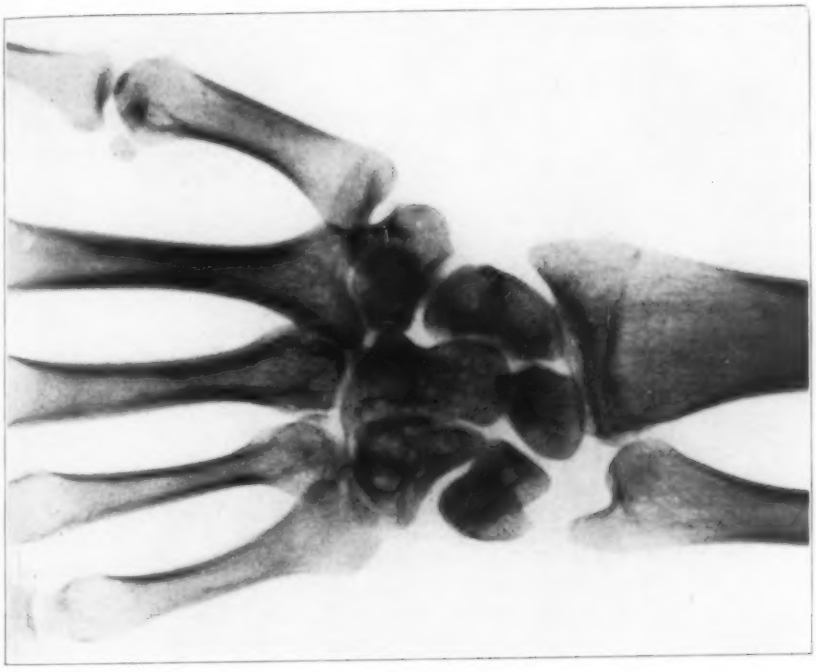

FIG. 4
Fracture of the os magnum.

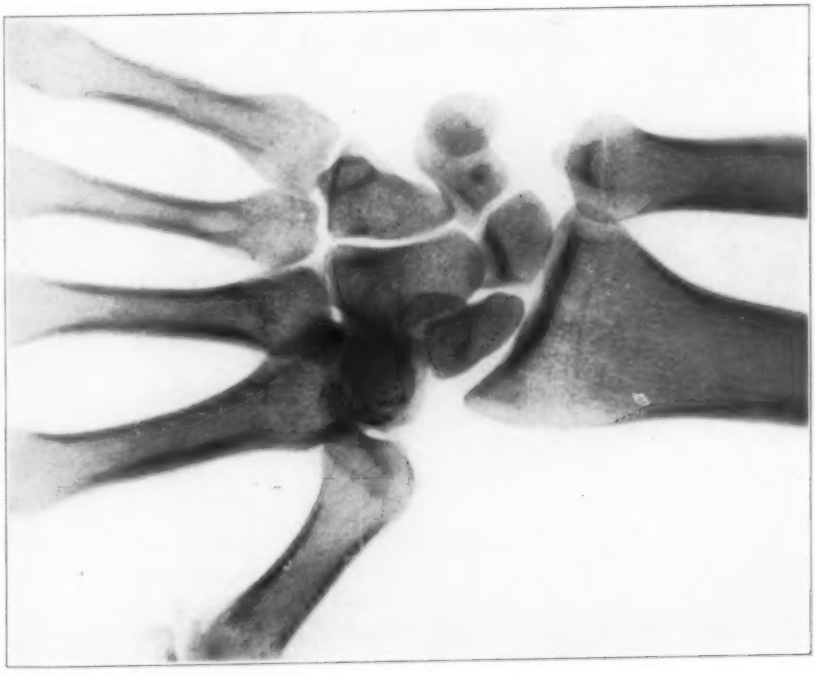

FIG. 3
Fracture of the os magnum.

REPORT OF CASES

CASE 1. Fracture of the trapezium (Fig. 1). Miss L., while crossing the street, was knocked over by an automobile. There were multiple contused areas, especially on the left side of the body, including a fracture of the lateral condyle of the left femur. She also complained of pain on the radial side of the left wrist, especially on motion of the thumb. There was some swelling on the radial side of the wrist and on x-ray examination a fracture of the trapezium was revealed.

CASE 2. Fracture of the os magnum (Fig. 2). Dr. R. awoke one morning complaining of pain in the right wrist. There was no history of trauma. On examination there was swelling of the wrist especially on the dorsal aspect with exquisite tenderness on pressure over the bone. An x-ray revealed the fracture.

CASE 3. Fracture of the os magnum (Fig. 3). Miss S., one of our nurses, slipped while walking in the corridor of the hospital. Attempting to break the force of the fall, she landed on her right hand. She immediately complained of pain in the wrist shooting down into the fingers, pain on motion of the fingers, with excruciating pain on pressure over the os magnum. The x-ray revealed a fractured os magnum.

CASE 4. Fracture of the os magnum (Fig. 4). Miss V. This patient gave a history of having fallen out of a first floor window, landing on her wrist. She immediately complained of severe pain in the hand and wrist, with inability to flex the fingers because of the severe distress such movements precipitated; inability to pick up objects and radiation of the pain along the course of the median nerve. When seen, the hand was markedly swollen, especially the dorsal aspect. Palpation revealed a very distinct localized area of tenderness over the os magnum which the x-ray showed to be a fracture.

CONCLUSIONS

1. Isolated fractures of the carpal bones, except for the scaphoid, are uncommon.
2. Three cases of fracture of the os magnum and one fracture of the trapezium are recorded.
3. Every injury of the hand or wrist should have a most thorough study, including a critical roentgenographic examination.
4. Many cases of so called "sprains", "synovitis", "arthritis", and "rheumatism" are in reality unrecognized fractured carpal bones.
5. Early recognition and adequate treatment are of extreme importance for the ultimate function of the wrist frequently depends upon this early knowledge.
6. Isolated carpal fractures result more frequently from indirect trauma, although direct injury may be the factor.
7. The prognosis in such fractures is usually good, since they heal by bony union.

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STRUCTURAL SCOLIOSIS SECONDARY TO SYRINGOMYELIA

Report of Three Cases

BY SAMUEL KLEINBERG, M.D., NEW YORK, N. Y.

The etiology of structural scoliosis has always been, and still is, obscure. The term idiopathic has come into use in relation to the vast majority of cases to indicate that the basic causal factor is unknown. Even the exact mechanism of the production of a scoliosis is still undetermined. But in some instances, the minority to be sure, the chief element in the origin of the muscle imbalance, or the postural change leading to the curvature, is apparent, and is considered etiologically responsible for the scoliosis. Thus rickets, infantile paralysis, torticollis, visual defect, empyema, disparity in the length of the lower limbs, and certain neurological lesions may lead to a structural scoliosis. Among the neurogenic causes Friedreich's hereditary ataxia is perhaps the most common. Of this type most any surgeon of experience has seen a half dozen instances. Syringomyelia, however, is an unusual and rare cause of scoliosis. In cases of syringomyelia scoliosis occurs often enough, but the disease itself is uncommon and rarely met in an orthopaedic practice. Neurologists take it for granted that scoliotic distortion of the trunk is a feature of syringomyelia, and are so engrossed in the disability resulting directly from the sensory, motor, and trophic lesions, that they pay little attention to the spinal deformity and seldom consult an orthopaedic surgeon.

Syringomyelia is a disease of the spinal cord alone, or the spinal cord and the brain. The essential pathological change is a destruction of the nervous tissue with cavity formation. The loss of tissue may be the result of a congenital malformation, a degenerative postnatal process, or an acquired infection. The symptoms consist of (1) dissociation of the sensory phenomena with loss of the pain and thermal sense, but not of the sense of touch; (2) motor phenomena varying from fibrillation and twitching of the muscles to distinct paresis; (3) trophic disturbances of the skin, muscles, and joints; and (4) gross deformities of the trunk and extremities.

Several cases are here recorded because: (1) syringomyelia is comparatively rare; (2) the patients exhibited characteristic and severe manifestations of the different groups of symptoms; (3) by a fusion of the spine of one of the patients, her posture and gait were improved and her disability reduced. This encourages the hope that early stabilization of the spine by an operation on the vertebral column may prevent the progress of the scoliosis to the customary severe degree, and may enable the individual to stand and walk more naturally and with greater ease.

CASE REPORTS

CASE 1. Elinor G., ten years old, was referred to me nearly one year ago by Dr. Elihu Katz for an increasing severe deformity of the spine and very great difficulty in walking. The birth of this child was attended by much manipulation and considerable trauma to various parts of the child's body. At the beginning of labor the buttocks presented. The obstetrician tried to turn the child but was not successful, and finally delivered it by a breach presentation. The mother was told that one of the collar bones was broken, and that the legs had been stretched a great deal in the course of the delivery. Immediately after birth the right arm had to be immobilized in a sling, presumably for fracture of the clavicle. It was noted also that the right eye was fixed; it remained so for three months. Furthermore, there was no power in either lower limb. The physical development of the child had evidently been interfered with, for the child did not begin to stand until she was four years old, and she was six years old before she could stand without assistance. The child's mental development was entirely normal.

FIG. 1

Case 1. Patient with structural scoliosis secondary to syringomyelia. Front and back views of patient with left lower limb prepared for traction. Note the severe scoliotic deformity of the trunk with telescoping of the chest into the pelvis, marked angulation of the ribs and obliquity of the pelvis. There are numerous scars on the back, some due to pressure sores and others resulting from skin-grafting operations.

The curvature of the spine was discovered when the child was six months of age; it increased continuously. During the first six years of her life this child received massage to her back and plaster jacket or corset supports. She then had a corrective jacket applied for the purpose of forcibly straightening her spine. This caused a terrific slough of the skin which took eight months to heal, and required extensive skin-grafting. At this time, about one year ago, it was first discovered, according to the mother's statement, that the child had a neurological disease.

Examination: January 14, 1932. The patient was in fair general condition. She was much undersize and underweight and was just about able to stand and walk a little without support. There was present a severe right dorsolumbar scoliosis (Fig. 1), with a moderate compensatory curve to the left in the upper dorsal area. There were numerous scars, some from

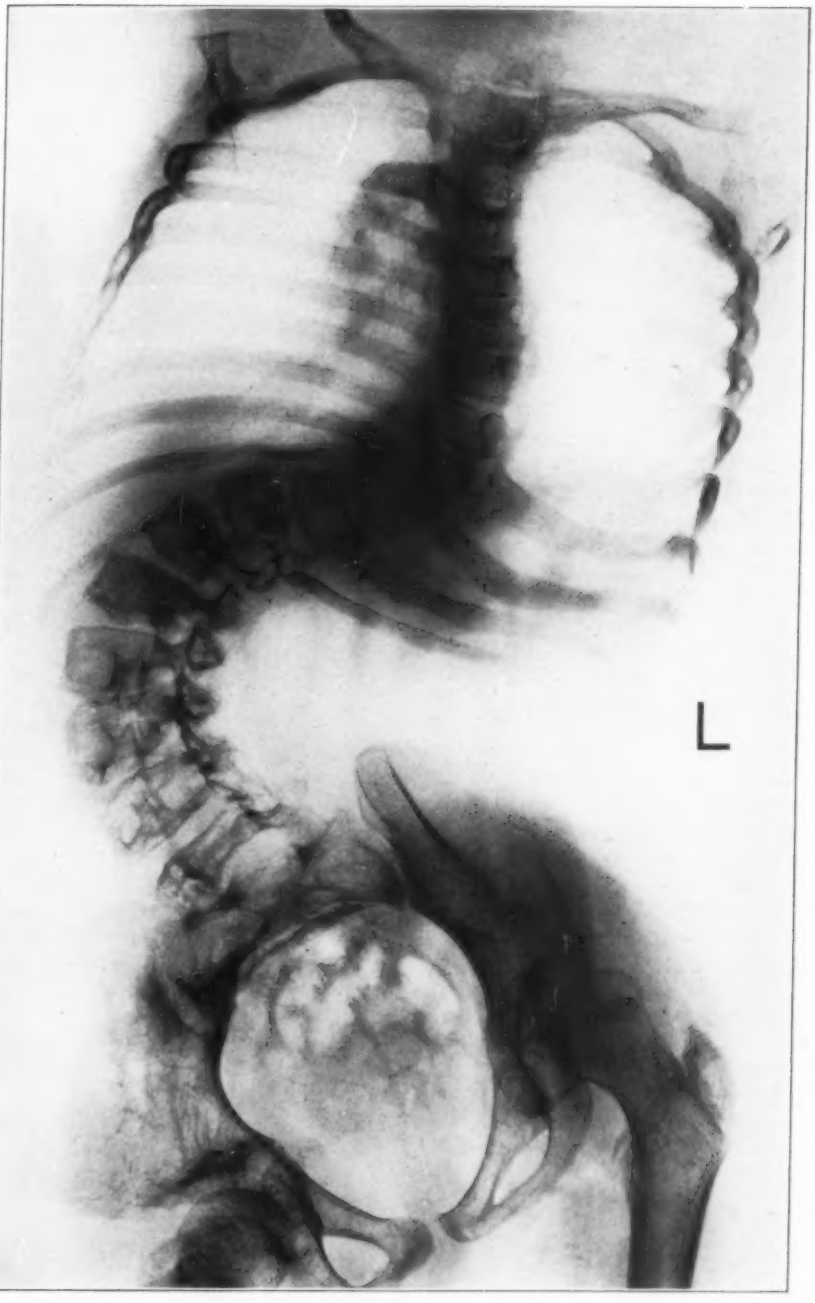

FIG. 2

Case 1. Anteroposterior roentgenogram, showing a severe right dorsolumbar scoliosis with marked rotation and deviation deformity of the vertebrae from the sixth dorsal to the sacrum. The obliquity of the pelvis is clearly visible. Note the closeness of the ribs to the pelvis on the left side.

pressure sores and others from attempts to skin-graft the ulcers. The pelvis was oblique, its right superior spine two inches below the left. The face and upper limbs were not affected, but there was marked involvement of the motor apparatus of the lower extremities.

A roentgenogram of the spine (Fig. 2) showed a severe right dorsolumbar scoliosis, with a marked lateral tilt of the pelvis. The pelvis, though much tilted laterally, was fortunately not otherwise distorted.

Neurological Examination: There was generalized atrophy of the muscles of the back, thorax, and lower limbs. The deep reflexes of all four limbs were not elicited. The plantar reflexes were equivocal. The abdominal reflexes were absent. A sensory examination showed that anteriorly from the fourth dorsal to the twelfth dorsal vertebra there was complete loss of appreciation of pin prick; touch was retained. The extremes of temperature (heat and cold) were not recognized as such in the areas from the fourth dorsal to the fourth lumbar anteriorly and from the fourth dorsal to the first lumbar posteriorly. The oculomotor apparatus and the cranial nerves showed no deviation from the normal. The fundi were normal.

The neurological examination indicated that this patient had syringomyelia, with a structural scoliosis arising from the imbalance of the muscles of the back. Nothing much in the way of therapeusis could be done for the central nerve lesion. However, something had to be done for the increasing deformity of the back which, quite aside from the troublesome features of the syringomyelia, was causing a severe disability. Experience in other institutions had shown that pressure sores appeared readily, and several times not only interrupted the treatment and nullified its good effects, but necessitated prolonged care for their healing, and, at least on one occasion, required skin-grafting. It was manifestly imperative to treat the scoliosis in order to prevent further increase of the curve. It was at the same time important to avoid ill effects from the treatment, such as pressure sores.

It was decided to apply the method of treatment which I have for years found to be the simplest, and withal the most effective, of the present systems,—namely, traction on a convex frame followed by a spine fusion. The patient was placed on a frame specially designed by my assistant, Dr. Herzmark. Traction was applied to the head and to the left leg. At the same time a box was placed at the foot of the bed between the right foot and the bed posts for counterpressure. The traction was gradually increased and was maintained for about four weeks, at the end of which time the back looked much improved and a roentgenogram showed that the curvature was considerably reduced (Fig. 3). The spine was then fused by operating on the vertebrae from the tenth dorsal to the sacrum inclusive. Although the patient was a poor subject for a spine fusion she stood the operation very well, and was in good condition when she left the operating room. The wound healed by primary union. Traction was reapplied at the end of two weeks. Six weeks after the operation a corrective plaster jacket was applied, including the left arm and left leg. The patient was kept in plaster for two months, after which she received a celluloid corset.

At present she is much improved. She walks much better than ever before and without any assistance. Her mother is particularly pleased because the child has become independent and gets about and does things for herself without constantly seeking help.

Case 2. Mr. A. B., thirty-seven years of age, recently consulted Dr. Milgram, to whom I am greatly indebted for the privilege of reporting the case. The patient's chief complaint was difficulty in walking of seven years' duration. The man was apparently well until his thirteenth year when it was noticed by his mother that his spine was becoming deformed. During the succeeding five years, despite active treatment, including recumbency on a convex frame, the curvature increased. While in bed a large ulcer appeared on his back, over the convexity on the right side. This never fully healed and is still a source of discomfort. During the following twelve years he got along tolerably well as a peddler. Seven years ago there appeared difficulty in walking, tiredness on

locomotion, and an inability to raise his right lower limb and bring it forward. This condition has grown progressively worse, so that at present he must hold on to the furniture to walk about the room. In addition, he has noticed in the past year that the "right leg has felt somewhat numb in places".

Examination showed the presence of a marked scoliosis as shown in the photograph

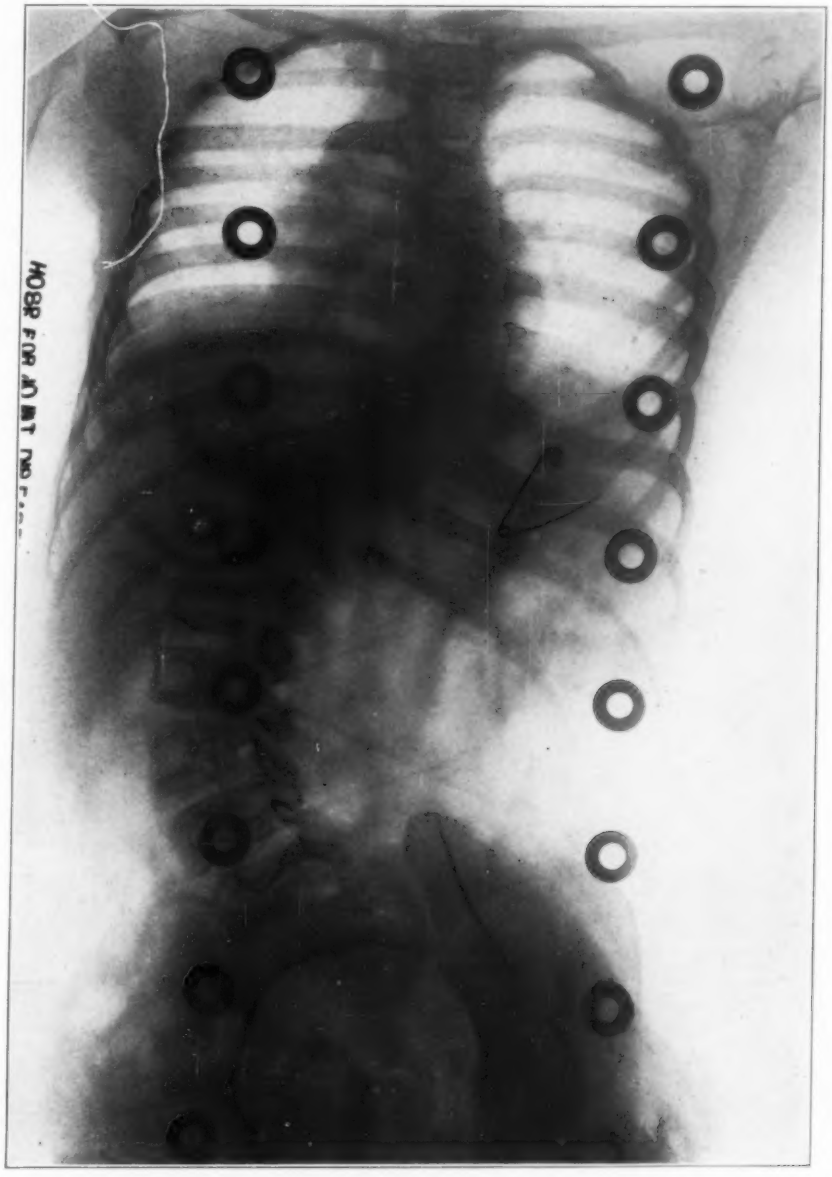

FIG. 3

Case 1. Anteroposterior view after several weeks of traction. Note the marked reduction in the curvature. There is an increase in the length of the trunk and the capacity of the chest and abdomen. The pelvic obliquity is improved.

(Fig. 4). The posterior view exhibits a large scar on the right side of the back,—i.e., the convex side of the curvature. The patient stands with his lower limbs flexed at the hips, knees, and ankles, as was seen in my first case. The gait is staggering, unsteady, and of the spastic type. The neurological findings indicate the existence of syringomyelia.

The salient features in this case are progressive deformity of the trunk, disturbance in the thermal sense, retention of the tactile sense, weakness

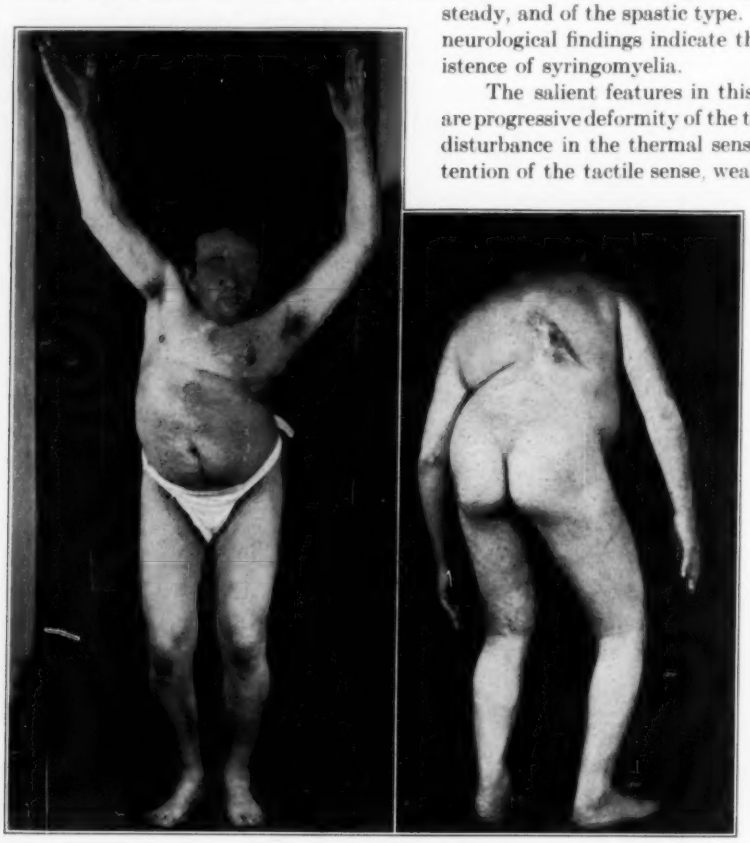

FIG. 4

Case 2. Front and back views showing a severe right dorsal scoliosis. Note the large irregular scar on the right side of the back. The attitude of flexion of the lower limbs is apparent.

in the muscles of the lower limbs, and marked alterations in the deep reflexes. From these findings one may conclude that the patient has a structural scoliosis due to syringomyelia.

CASE 3. Samuel H., thirty-four years old, consulted my associate, Dr. Joseph Buchman, for paralysis of the left upper limb. The patient had no difficulties until three years ago when he noticed some stiffness in the left middle finger. This was followed by the onset of weakness which involved progressively the hand, forearm, and arm. Recently the shoulder became affected so that the patient had very little power in the whole of the left upper limb. The onset of this weakness was accompanied by pain along the left side of the head radiating down to the point of the shoulder. Ten weeks ago stiffness and weakness appeared in the right upper extremity and more recently similar symptoms were experienced in the left thigh.

Examination showed that the patient is a well nourished individual with a marked right cervicodorsal structural scoliosis (Fig. 5). There is a left Horner's syndrome,—

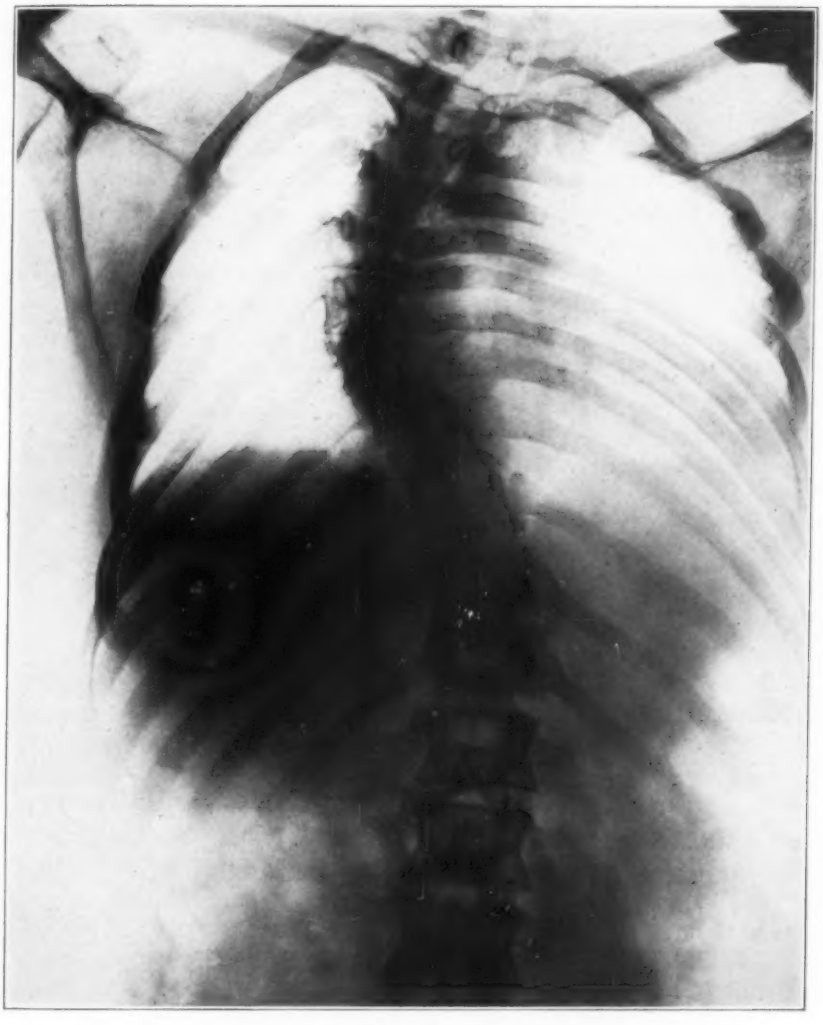

FIG. 5

Case 3. Anteroposterior roentgenogram of spine, showing a marked right dorsal structural scoliosis with the usual changes in the thoracic cage.

that is, the left pupil is abnormally small, the palpebral fissure is narrowed, and there is an enophthalmos. Sensation in the face is normal and there are no bulbar disturbances. The extremities and trunk present sensory and motor disturbances and changes in the reflexes that are characteristic of syringomyelia. This patient, as the two previous, has a structural scoliosis complicating a preexisting syringomyelia. There was no opportunity for treatment of the spinal curvature.

DISCUSSION

The cases here detailed are typical of syringomyelia exhibiting the usual neurological changes. In the history of all of the patients it is apparent that in this lesion there is early a strong tendency for the curva-

ture of the spine to progress to a severe degree. While most of the motor disturbance, general instability, and locomotor disability is due to the lesion of the spinal cord, yet it would seem reasonable to believe that the deformity of the spine and trunk may contribute toward the disability. Moreover, even if that were not so, it would be advantageous to check, if possible, the progress of the curvature. With that in mind the first case, a child, had a spine fusion operation. It is too soon, indeed, to be certain of the final outcome, but from present appearances, and from the experience in other types of severe scolioses, the spine seems stabilized and the scoliosis under control. The other cases were in adults in whom the deformity was already advanced and in whom there was no opportunity for spine fusion.

Although the etiological factor—namely, an organic lesion of the spinal cord—is beyond our reach, we should not hesitate to apply orthopaedic treatment for the curvature. Some years ago I had several cases of scoliosis secondary to Friedreich's hereditary ataxia. The patients were much improved by continued support of the back with corsets. In at least one of them improvement progressed so far that the patient was able to resume her studies in college, and she acquired enough motor steadiness so that she was able to walk several miles a day. At present I have under my care a boy with scoliosis secondary to Friedreich's hereditary ataxia. As his deformity was increasing, I fused his spine. There has been no further increase in the deformity and the boy is getting about freely and with greater ease. I believe, therefore, that in syringomyelia the spine should be operated on as early as the diagnosis is established for the following reasons: (1) to stabilize the spinal column and thereby improve the posture and gait, (2) to prevent increase of the curvature.

A NOTE ON POSTURE IN RELATION TO FLAT FEET

BY L. E. SNODGRASS, M.D., PHILADELPHIA, PENNSYLVANIA

Episcopal Hospital, Philadelphia

Flat feet occurring in patients with poor posture is an every-day observation. The emphasis in the past, however, has been largely directed toward the kyphosis part of the deformity in this relationship. The purpose of this brief paper is to stress the effect of the constant compensatory lordosis. These observations are based on a study of the anatomy involved, on the cadaver, and in the living.

For all practical purposes, it may be accepted that the pelvis moves with the lumbar spine. Lordosis is accompanied by rotation of the pelvis about a transverse axis drawn through the femoral heads, so that the iliac crests move forward and the symphysis pubis downward and backward. In this manner the upper attachment of the fascia lata to the pelvic brim is moved forward, and by its hammock-like function, which was clearly demonstrated by Allis [1] in 1896, brings the great trochanter forward in relation to the pelvis in the standing position. This forward movement of the great trochanter is internal rotation of the leg.

In a foot with normal arches, the internal malleolus is found somewhat anterior to the external malleolus. In the patient with flexible pronated flat feet, it will be found that this relationship is disturbed and that the malleoli are directly opposite one another, or more nearly so. Selecting an intelligent patient with definite flexible pronated flat feet, and with the feet pointing directly forward,—*i.e.*, parallel but not in contact with each other, the patient is instructed to stand at ease. After carefully noting the position of the malleoli, the patient is requested to turn his legs outward, but not to move his feet. It may be necessary to hold the fore part of each foot on the floor to demonstrate the external rotation of the leg on the foot which takes place. By this movement the posterior part of the foot rotates outward with the leg, so that the scaphoid goes upward and laterally and the upper part of the os calcis moves laterally, bringing the attachment of the tendo achillis inward where it comes to lie in its normal position over the mid-line of the ankle joint. It should be noted that the origin of the gastrocnemius is moved laterally by internal rotation of the leg, which tends to tilt the upper part of the os calcis inward.

The writer is keenly aware of the danger of confusing cause and effect in any study of flat feet. One may accept the view that flat feet is but one manifestation of weakened muscles and ligaments throughout the body, requiring no further anatomical explanation. But, if this position is taken, then one must explain the constant escape of the knee joint from derangement, for, second only to the joints in the foot, the knee transmits more body weight than any other freely movable articulation. It is

recognized that back-knee and lateral mobility of the knee are very uncommon findings in patients with flat feet. It is true that patients with bilateral congenital dislocation of the hip develop lordosis, but do not invariably have flat feet. In these patients, however, the lordosis is definitely secondary to the condition in which the pelvis is supported from points posterior to the acetabulum.

The correction of the posture should be our first aim in treatment. Whether or not we regard the lordosis as primary, by its correction we will more permanently correct the flat feet than by simply bracing up the arches by shoes with pads or plates. The correction of the deformity in the foot should not be neglected, but the weight of the body and its leverage through the internal rotation of the leg will prevent a permanent improvement of the foot condition until the posture is corrected.

1. Allis, O. H.: An Inquiry into the Difficulties Encountered in the Reduction of Dislocations of the Hip. The Samuel D. Gross Prize Essay, Philadelphia, 1896.

EWING'S TUMOR: AN UNUSUAL CASE

BY ALEXANDER S. PAPADOPOULOS, M.D., ATHENS, GREECE

Chief Surgeon of the Orthopaedic Section in the General Hospital for Refugees, Athens, Greece

Endotheliomata of the bone, however rarely they may occur, constitute, nevertheless, a well defined morbid entity. Following is the first case of endothelioma of bone recorded in Greece. Our indebtedness to the American authors for their thorough study and knowledge of this disease is a recognized fact. In spite of a certain number of disputed points which still prevail as regards its origin and initial starting point, Ewing's tumor is accepted today as a well defined clinical, anatomico-pathological entity.

Authors refer, as a rule, to the great similarity which exists between Ewing's tumor and the most common of bone affections, such as the chronic osteomyelitis of tuberculosis; if error and confusion are common in the usual forms of Ewing's tumor, they are inevitable when the tumor has a juxta-epiphyseal development. Error is always possible in clinical work, especially in cases as rare and uncommon as Ewing's tumor, in which, except for the anatomical characteristics of the tumor, no sign nor symptom possesses a real pathognomonic character. However, the perusal of a large number of reported cases gives the impression that the initial symptom as revealed by the roentgenogram—namely, that of a bone condensation—is an important one which should always be taken into consideration as a serious inference of Ewing's tumor.

In the case reported the truth of this fact was evident and constitutes the principal reason for its publication.

CASE REPORT

H. S., female, aged nineteen, from Asia Minor, with a negative previous history and in good general health, in January 1931 began to complain of slight pain in the left knee joint which was attributed to an excess of walking. The pain became gradually more pronounced and she was obliged to apply to our Hospital Dispensary for advice. At this time, March 1931, there was no local manifestation to explain the persistence of a deep, constant pain in the knee joint; movements were entirely free; there was no swelling and no difference in the circumference of the limbs. The only suggestive sign was a painful point situated on the upper and inner portion of the tibia. The laboratory examination of the blood was negative as regards the Wassermann reaction and there was no alteration from normal composition and number of the red and white corpuscles. The roentgenographic examination was important because it disclosed a dark area of bony condensation situated on the inner portion of the tibial epiphysis, which was of difficult interpretation. Because of the slight degree of emaciation and pallor, the possibility of a local tuberculous reaction in the epiphysis of the tibia was considered, for which rest and general treatment were recommended.

The patient returned one month later without amelioration of the pain, presenting on the contrary a number of new painful areas about the knee joint. The diagnosis of tuberculosis seemed confirmed, and a plaster cast was immediately applied with a window for sun exposure.

FIG. 1

Roentgenogram taken March 13, 1931.

The symptoms gradually increased in severity. The patient suffered continually, and it was necessary to remove the cast one month later. At this time the upper portion of the leg presented a clear swelling, with fluctuation and marked local irritation of the knee. The roentgenogram showed a longitudinal and irregular extension of the dark shadow, forming a column an inch in length, with a zone of rarefied bony tissue on the outer side, but the periosteum did not seem to be involved in the local process. An onion-like formation seemed apparent on the outer side of this dark column. The clinical signs recorded at that time were: atrophy of the thigh two-thirds of an inch, local swelling and elevation of temperature, with appearance of dilated subcutaneous veins. The diagnosis of tuberculosis could no longer be held, but the condition indicated the presence of some uncommon inflammatory process or a rare variety of tumor which was beginning with a strong reaction of bony condensation. Ewing's tumor suggested itself to us and biopsy was advised with the possibility of a radical operation if necessary after anatomico-pathological confirmation. The advice was not followed and the patient consulted another surgeon who made the diagnosis of tuberculosis and the limb was again immobilized in plaster-of-Paris.

Two months later, the patient returned to the hospital, showing exhaustion, emaciation, and pain and marked swelling of the knee.

On June 10, 1931, under a general anaesthesia, biopsy was attempted with the expectation of finding a tumor. After opening, there was found pure blood and a number of small organized granulations contained in a false cystic cavity in the compact tibial bone, the hard steel-like consistency of which confirmed the x-ray diagnosis. There being no further evidence to confirm the macroscopic nature of the lesion, we did not feel free to proceed to a radical operation. The wound healed by first intention. The laboratory reports, however, were as follows: "No microbe or other organism; the examination of a portion of the tissue showed ordinary cells which are usually found in inflammations, and nothing more." The report was in obvious contradiction to the clinical evolution of the disease.

The swelling rapidly increased and, at the end of July, x-rays showed marked extension of the lesion, with the destructive process in advance of the condensation at this time. Emaciation was extreme and, in spite of the negative laboratory findings, amputation of the thigh was performed.

Examination of the tumor gave the following findings: "The histological examination of the tumor proves it to be of a small round-cell sarcomatous structure, rather of a peritheliomatic character. As a rule, the cellular disposition is alveolar, or, rather,

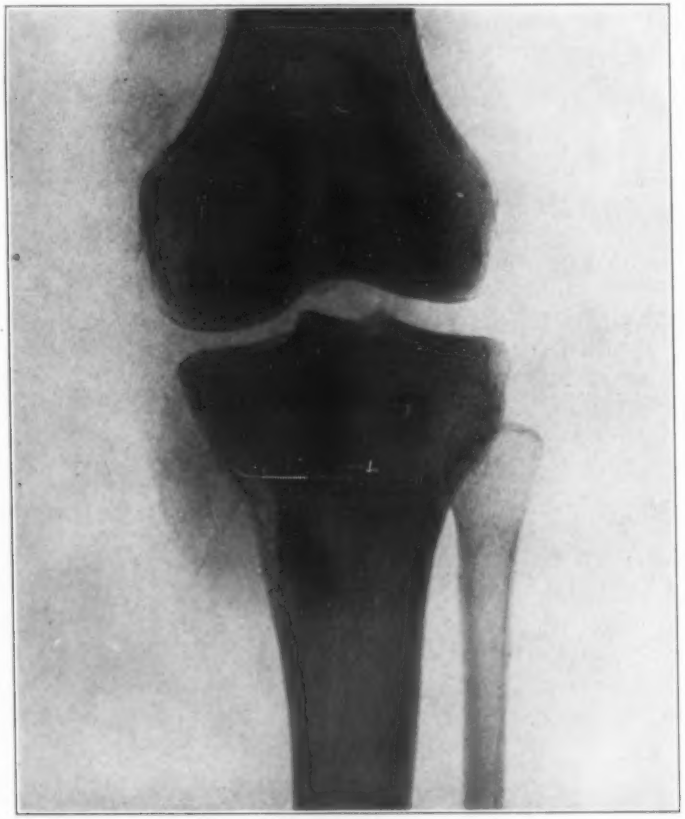

FIG. 2
Roentgenogram taken April 29, 1931.

FIG. 3
Roentgenogram taken June 17, 1931.

pseudo-alveolar. The cells are small and polyhedral, with one nucleus round or oval. No nucleoli. Some atypical mitotic forms are found here and there. The cells form a regular sheet, interrupted here and there by newly formed vessels or fibrous tissue. The abundance of the newly formed vessels and the irregular mitosis of the cells suggest the extreme malignancy of the tumor.

"Macroscopically, the tumor is suggestive of the bony myelomata, vascular, and divided by fibrous columns."

The patient made some improvement after the operation, but returned in January 1932 with double hemothorax, dyspnea and intrathoracic pain. The x-ray showed double hemothorax, but no metastasis could be determined. The patient died on March 8, 1932. Autopsy was not permitted.

The case was interesting from several points of view. After first presenting for some weeks a vague resemblance to tuberculosis of the tibia, a clearly circumscribed point of condensive osteitis was shown by the x-ray, which is rarely ever found in tuberculosis. This important information given by the x-ray is, in our opinion, one of the most important indications in favor of Ewing's tumor, since in no other inflammatory or neoplastic process is this local reaction usually met. We agree with Herendeen's assertion that the diagnosis of Ewing's tumor can be made from the roentgenograms alone, and this was true in this case during the entire duration of the illness. The biopsy itself was not devoid of practical instructive results, for it revealed the local anatomical characteristics of Ewing's tumor in which only blood and rare small particles were found, and these were taken by the pathological laboratory to be the result of ordinary inflammatory reaction. These anatomical irregularities are frequently mentioned in Ewing's tumor bibliography and one is tempted to question if many of these errors are not the result of incomplete intracellular examination rather than, as is maintained by some authors, the result of a coexistence of ordinary inflammation usually preceding the neoplastic transformation.

In spite of its rarity, Ewing's tumor is an interesting variety of malignant tumor and every case should be published and studied thoroughly. We wish to acknowledge our indebtedness to the excellent review of the subject contained in the article by Dr. Sevier.[1]

1. Sevier, C. E.: Ewing's Tumor (Endothelial Myeloma). Report of an Atypical Case. J. Bone and Joint Surg., XII, 929, Oct. 1930.

TUBERCULOSIS OF THE HIP JOINT FOLLOWING CLOSED REDUCTION OF CONGENITAL DISLOCATION OF THE HIP *

BY CHARLES N. PEASE, M.D., F.A.C.S., CHICAGO, ILLINOIS

Changes in the head of the femur and acetabulum following closed reduction of congenital dislocation of the hip joint are not uncommon. Osteochondritis deformans (Legg's disease), atrophy of the femoral head, non-specific epiphysitis with thickening of the neck of the femur and a true traumatic arthritis of the hip joint occur frequently, but tuberculosis involving the hip joint following reduction has not hitherto been reported.

The following is a case report describing such a complication.

L. E., white girl, eight years old, was admitted on October 10, 1931 to the Orthopaedic Service of the Children's Memorial Hospital. A typical history of congenital dislocation of the left hip was obtained. The first reduction was accomplished when the child was six years old, but subluxations on two occasions required further manipulations and casts. Birth was normal. There was no history of tuberculosis in the family. On this admission patient walked with a limp on the left side. Motion of the left thigh was

FIG. 1

Typical unilateral congenital dislocation of hip.

* From the Orthopaedic Service of Dr. Fremont A. Chandler at the Children's Memorial Hospital. Presented before the Joint Meeting of the Clinical Orthopaedic Society and the American Academy of Orthopaedic Surgery at Chicago, January 14, 1933.

FIG. 2

Following first reduction. There is a subluxation with loss of outline of joint space.

limited in all directions by involuntary muscle spasm. The Von Pirquet test was negative. Roentgenogram revealed the head of the femur not completely replaced in the acetabulum. There was a thinning of the joint space and a marked atrophy of the left ilium and femur. A diagnosis was made of an incomplete reduction of congenital dislocation of the hip plus a superimposed arthritic process.

On October 14, 1931, under a general anaesthesia, the hip was abducted and internally rotated and, with the knee slightly flexed, a spica cast was applied. Ten days later the laboratory reported finding, from smears obtained from the nose and throat, streptococcus viridans, staphylococcus aureus, and micrococcus catarrhalis. Cultures from the stool revealed bacillus coli, streptococcus viridans, and staphylococcus aureus. Blood cultures after twenty-four hours, forty-eight hours, and seven days were negative. Intracutaneous test with streptococcus viridans was positive. The patient was discharged from the hospital on November 11, 1931 to the out-patient department where she received weekly injections of autogenous vaccine.

She was readmitted to the hospital on January 8, 1932, when the cast was removed. Mantaux test, minus one-tenth milligram, was made and in twenty-four hours it was definitely positive. Roentgenograms at this time showed an excessive amount of bone atrophy of the left hip and a loss of the bone outline in the joint suggestive of tuberculosis.

On February 9, 1932, an exploration and biopsy of the left hip joint were performed. On inspection there was no free fluid present in the joint. There was very little granulation about the head of the femur. The cartilage of the femur was very atrophic and thin; its usual luster was absent and a dark gray color replaced the usual blue-white appear-

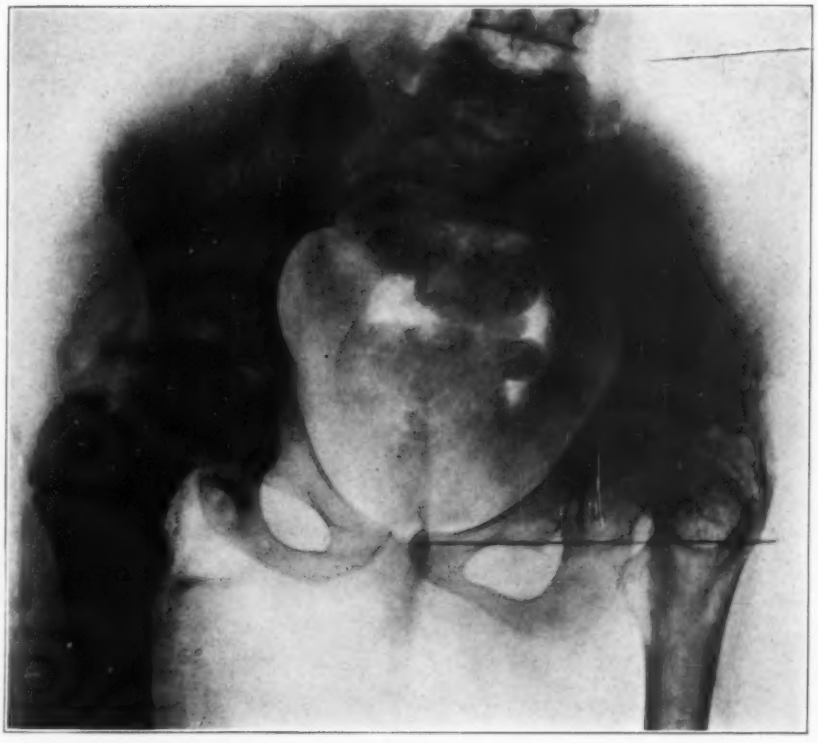

FIG. 3
Complete extra-articular fusion of hip joint.

ance. The capsule was definitely thickened. A small area of dark abnormal tissue was present in the capsule. The impression was that this joint was not tuberculous but rather one which had been subjected to much trauma.

Synovia and a small portion of the head were removed for biopsy. Pathological examination of the tissue showed chronic hyperplastic inflammation compatible with tuberculous granulation tissue. A portion of this tissue was macerated and with it smears, cultures, and guinea-pig inoculation were made. Paraffin sections of other portions of the same tissue were also made. In the direct smears no acid-fast bacilli were found. The cultures remained negative. Guinea pig was killed and autopsied seven weeks after inoculation and tubercles were demonstrated histologically.

On April 12, 1932, through a Smith-Petersen incision an extra-articular fusion was performed. Patient wore a spica cast until September 29, 1932, at which time the hip was firmly fused both clinically and roentgenologically.

COMMENT

It is suggested that all patients having persistent involuntary restriction of motion of their hip joints, following reduction of congenital dislocation of the hip, be studied carefully for possible foci of infection causing a secondary involvement of the joint. In addition, the various examinations for tuberculosis should be undertaken and, even if found to be negative at first, a repetition of the examination is indicated.

CARTILAGE OF THE OUTER CONDYLE OF THE FEMUR AS A FOREIGN BODY IN THE KNEE JOINT

BY G. A. CARLUCCI, M.D., NEW YORK, N. Y.
Associate in Surgery, Columbia University, New York

Many cases of foreign bodies in the knee joint have been reported, but a casual perusal of the literature does not reveal one due to practically the whole cartilage of the outer condyle of the femur.

Due to its unusual features this case is reported in detail.

FIG. 1

Anteroposterior view of both knees. *A*. Crescentic shadow first noted near the exostosis. *B*. An evident exostosis.

A twelve-year-old girl was first seen by me November 11, 1932. She stated that over three months previously she had twisted her knee as she jumped off a trunk. The exact mechanics of the accident she could not describe. The knee pained her for a while and she was treated with the usual home remedies,—liniment, etc. Some time later, as she continued to limp, she was taken to her local physician who at first treated the condition as a sprain and then, as a chronic swelling of the knee developed, made a diagnosis of rheumatism, gave her salicylates, etc., without any improvement.

As stated above, she was referred to me about three months after the accident. The child walked with a decided limp, had a diffuse swelling of the whole left knee joint, seemed to have a tender spot on the outer side of the outer condyle of the femur, had about twenty degrees of limitation of flexion, full extension, and no lateral mobility of the knee. There was some fluid in the joint proper, as evidenced by the patellar click. There was no atrophy of the muscles and no heat about the joint. Closer examination of the outer side of the external condyle seemed to show the presence of a bony prominence, probably an exostosis.

FIG. 2

Anteroposterior view taken two days later. *A*. Crescentic shadow in the reverse of its previous position and farther away from the exostosis, *B*.

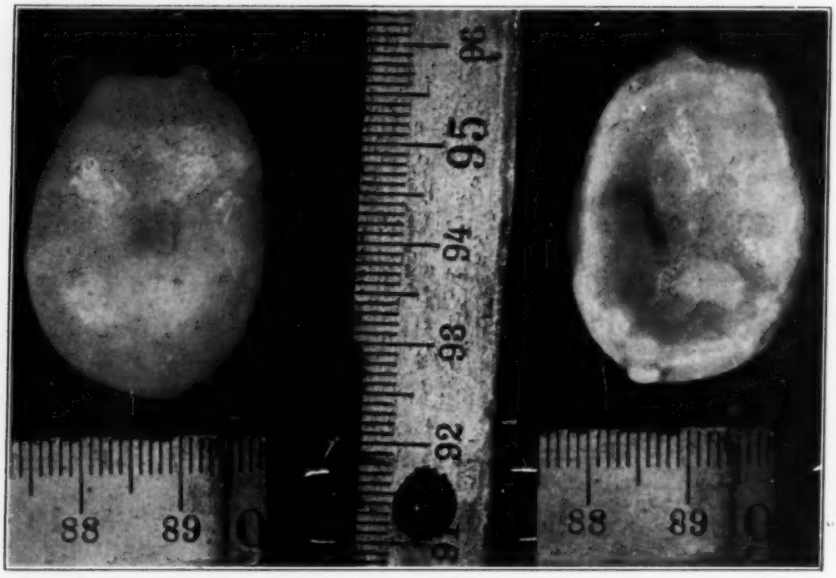

FIG. 3

Foreign body (cartilage of external condyle of femur). Convex side shown at left; concave side, at right.

A tentative diagnosis of an exostosis arising at the site of a partly torn lateral ligament with a chronic synovitis was made and roentgenograms were taken. Fortunately large films were used, taking both knees in the anteroposterior position on the same film. Lateral views were also taken of both knees. In the anteroposterior views the exostosis on the outer side of the knee was readily seen, but just above it a peculiar shadow somewhat crescentic in shape was noted. Whether it was an extension of the exostosis or a beginning myositis ossificans could not be determined at that time.

The knees were again x-rayed the following day and this time the crescent-shaped shadow was completely reversed as compared with the previous picture. A close study was then made of the lateral film and it became apparent that the inferior surface of the outer condyle of the left knee was eroded and apparently lacking in the full curve, as compared with the inner condyle. This difference was also noted in comparing it with the film of the good knee. A diagnosis of a loose cartilage in the knee joint was made and the youngster operated on November 15, 1932.

A four-inch longitudinal incision was made on the outer side of the knee and the joint capsule was found to extend laterally way over to the exostosis on the superior margin of the external condyle. The exostosis was chiseled off, the joint capsule opened, and the fluid evacuated; the loose body was then found under the quadriceps extensor and extracted. The capsule and the skin were sutured with catgut and the knee put up in extension on a splint for a week. The patient was gradually allowed to walk.

She was seen about four months after the operation and roentgenograms were taken. At that time she had only a very slight swelling of the knee, no pain at any time, was going to school regularly, walking without a limp, and had complete range of flexion and extension of the knee. There was no demonstrable lateral mobility. The roentgenograms showed that there was still a roughening of the articular surface in a small area.

This unusual case is reported on account of the fact that the foreign body in the knee joint was nearly the whole cartilaginous surface of the outer condyle of the femur and that it was apparently the result of a very

FIG. 4

Lateral view of normal knee joint (right) showing even contour of condyles of femur.

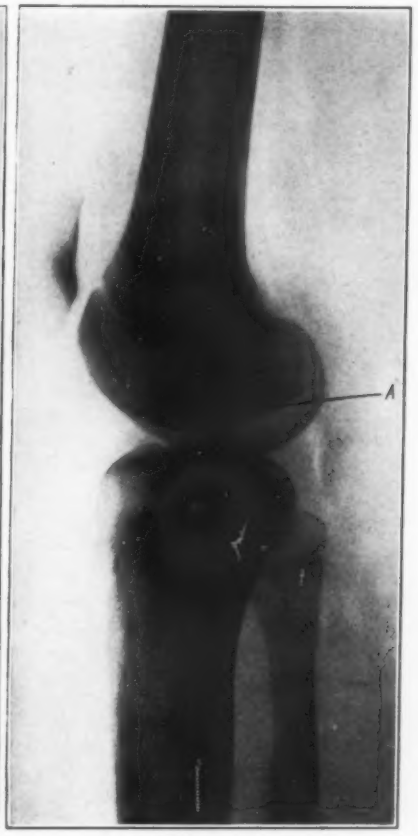

FIG. 5

Lateral view of left knee joint showing irregular contour of external condyle. *A*. Loose cartilage not seen.

minor injury. Whether the exostosis was also the result of the injury could not be determined. As a matter of fact it was extra-articular.

It is interesting to note also that the synovial membrane of the knee joint in this case extended well out under the vastus externus, allowing the cartilage to gravitate there and in this manner appear on the roentgenogram. As a matter of fact, at operation the foreign body was under the quadriceps extensor, just above the patella, and I doubt very much if the very fine crescentic line would have been noted in the first roentgenogram if it had been there at that examination. This, of course, emphasizes the fact that it is of the utmost importance to x-ray all these apparently trivial injuries in order to prove that there is no bone injury. As in this case, comparative roentgenograms of the normal joint are of great value; and, whenever there is any doubt, a check-up roentgenographic examination should be made.

The author wishes to make acknowledgment of the excellent roentgenograms of this case taken by Dr. D. Sandroni.

FIBULA TRANSPLANT TO REPAIR DEFECT IN RADIUS

BY ROBERT D. SCHROCK, M.D., AND HERMAN F. JOHNSON, M.D.,
OMAHA, NEBRASKA

University of Nebraska, Department of Orthopaedic Surgery

A woman, aged twenty-four, presented the problem of a giant cyst of the left radius. "Prickling sensations" in the forearm and swelling were noted six months previously.

Roentgenographic studies of the left forearm on August 10, 1930, "show a cystic expansion of the radius, beginning about two inches below the head and involving a portion of the shaft about two and one-half inches in length. The cortex appears unbroken, but is displaced widely into the soft tissues, making the total width of the radius about three times its normal diameter. There is extensive loss of lime salts from the bone, with no evidence of bone production. The cyst is crossed irregularly by three trabeculations, which grow more numerous as the shaft is approached."

The giant cyst was resected intact with about one-half inch of radius at each extremity, through bone appearing grossly normal. The radial defect was four inches long.

A four and one-half inch segment of fibula with its periosteum was removed; multiple drill holes were made through cortex to medulla at varying levels. The proximal end of the radius was slit incompletely in the horizontal plane; the distal end was slit in the vertical plane; a very narrow wedge of bone being removed from each. The ends of the fibula graft were thinned in corresponding planes; the length of the graft was determined to be slightly longer than the radial defect in order to produce longitudinal stress when set in place.

Progress was uneventful. Contour of the forearm had been restored to normal. Roentgenographic study showed satisfactory development. At the end of seven months (March 17, 1931) the report read: "The fibula transplant has remained viable at each end. It is firmly united to the radius by callus. The proximal point of union is rather indistinct and shows complete union of bone. At the distal end, fibula and radius can still be differentiated. Union is complete." (H. B. Hunt, M.D.)

At this time, no support was being worn. The function of the forearm and hand was ninety per cent. of normal, pronation being slightly limited.

The making of multiple small drill holes through cortex to medulla did not materially weaken the graft and did permit more rapid vascularization of the graft throughout its length. The wedged ends of the graft under pressure in the slotted radial ends brought fibular and radial medullary cavities into intimate contact. Attention was given carefully to avoid torsion strain. These details of presenting opportunity for early vascularization of both medulla and periosteum, together with the exertion of longitudinal pressure, are essential factors in the successful outcome of the four-inch graft of fibula into the radial defect.

FIG. 1-A

Fig. 1-A. August 18, 1930.
Fig. 1-B. September 2, 1930.
Fig. 1-C. September 2, 1930.
Fig. 1-D. March 17, 1931.
Fig. 1-E. March 17, 1931.

FIG. 1-B

FIG. 1-C

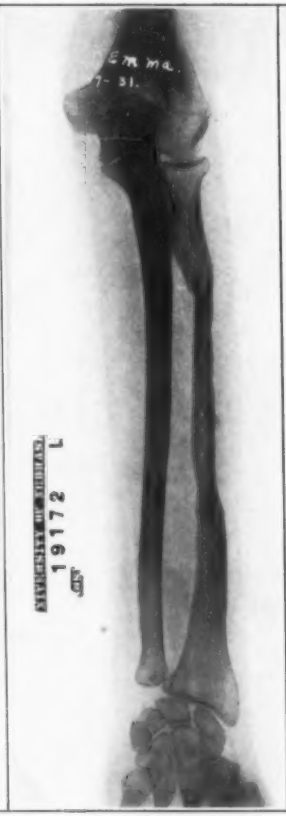

FIG. 1-D

FIG. 1-E

A CASE OF ARTHROKATADYSIS OF THE HIP JOINT

BY EDWARD N. REED, M.D., F.A.C.S., SANTA MONICA, CALIFORNIA

This case is reported as another instance of the condition recorded by Dr. Pomeranz as "Intrapelvic Protrusion of the Acetabulum", and by Dr. Cary and Dr. Barnard as "Arthrokatadysis of the Hip Joint", in *The Journal of Bone and Joint Surgery* of July 1932 (XIV, 663, 687).

A young woman, a graduate nurse, came for examination and treatment because of aching in her right hip and thigh.

Complaint:

Since sixteen years of age she has had intermittent aching in the right thigh, from the hip to the knee, brought on by any considerable amount of walking or standing or by a long automobile ride. She is unable to take part in any athletic sport. There is no aching in the left lower extremity and no manifestation of trouble in any other joint at the present time.

History:

She walked at eight and one-half months. Had the exanthemata of childhood but none unduly severe. Never had scarlet fever or diphtheria. Between four and eight years of age she had, each spring, for three successive years, a severe attack of rheumatic fever, involving principally the feet, knees, and hips, lasting two to three weeks each

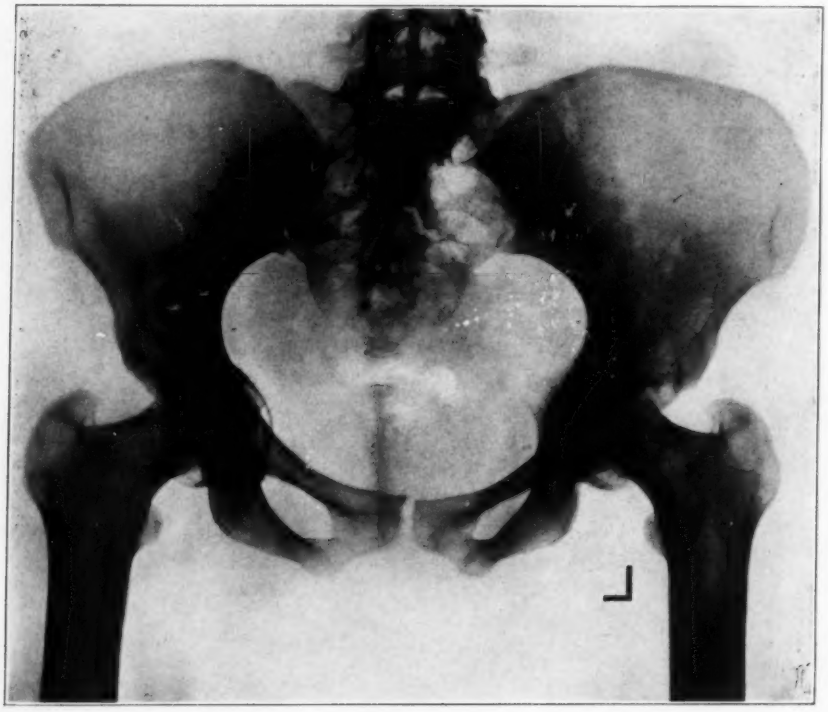

FIG. 1

time, but without endocardial involvement or chorea. She was repeatedly obliged to miss school because of "colds" and tonsillitis until ten years of age, at which time her tonsils were removed. She had no more rheumatism after the tonsillectomy, following which she grew very rapidly, having previously been an unusually small child. Throughout adolescence she was very round-shouldered. She played like any other child in grade school but would get very tired. Was obliged to give up basket-ball in high school, because of the reaction it produced in the right hip.

At eighteen years of age she had a severe attack of pain in this hip, causing thigh flexion for two weeks, followed by progressive improvement. In March 1927, roentgenograms were said to have shown a softening of the femoral head. She was put in a hip spica cast, in abduction, for seven weeks, with no weight-bearing for six more weeks. Roentgenograms were taken again in 1928, and she was advised to have complete rest and heliotherapy but, disregarding this advice, continued her nurse's training. The condition progressively improved; at present she complains of aching after a busy day on her feet or a long automobile ride.

Examination:

A healthy and vigorous young woman, twenty-four years of age; height, sixty-four inches; weight 148 pounds; of obese, short-necked type; with remarkably clear, fair skin; with a definite girdle obesity; long, tapering fingers; teeth not spaced. She walks with a peculiar stilted gait, making one think at once of a congenital dislocation of the hips.

Her pelvis is level; she has a marked head forward position, with shoulders drooping forward. The spine kinks sharply at the dorsolumbar junction and she has a marked lordosis. The right waist angle is more acute and she has a moderate left total curve. In Adam's position her spine is straight and her finger tips come within five inches of the floor. She has a moderate knock-knee, but very good foot statics.

The right thigh abducts thirty degrees and the left forty degrees. Outward rotation of both thighs is normal, inward rotation blocks at one-half of normal. The hip joint tests are all negative, as is Ely's test. Hyperextension of her spine is normal.

Her blood Wassermann is negative and her entire blood picture a normal one. The urinary findings are negative.

TRAUMATIC UNILATERAL GENU VALGUM

Report of Case

BY DENIS S. O'CONNOR, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT

Yale University School of Medicine, Department of Surgery

The following case is reported because it illustrates a condition arising from trauma which is not always demonstrable by roentgenogram but may give rise to pathological development of a physiological process and result in deformities and disabilities.

J. R., three years of age, was seen in consultation on April 5, 1927, for a marked unilateral genu valgum and a peculiarity of gait. Five months before he had been injured when an automobile ran over the cart in which he was sitting. His specific injury was a fracture of the left tibia about four inches below the knee. The fracture was demonstrated by roentgenogram and a plaster-of-Paris cast was applied from the toes to the mid-thigh. Recovery was uneventful until the cast was removed when it was seen that the left leg was definitely deformed in valgus, a condition which did not exist to any noticeable degree before the injury. The attending surgeon considered the condition to be more apparent than real and manifested confidence that the condition would disappear when the child began to walk. When the child began to walk, the deformity was not only more noticeable, but the child walked in such a peculiar manner that he was referred to an orthopaedic surgeon for an opinion.

Examination showed a marked unilateral valgus deformity of the left knee and an increase of one-half inch in length in the affected leg. New roentgenograms showed good repair of the fracture with no evidence of deformity at the site of fracture.

From a consideration of the mechanism of the production of the fracture and its location, it was evident that the medial side of the upper tibial epiphysis had been separated with the concomitant hemorrhage into the structures about the epiphyseal growth cartilage. It is a well known fact which finds clinical application in the treatment of retarded growth in the long bones in anterior poliomyelitis that traumatic irritation of the epiphyseal growth disc will speed up the growth in the epiphysis. This was the most reasonable and only explanation for the condition found in this case.

The condition was treated by raising the sole and heel of the shoe on the unaffected leg to nearly compensate for the shortening. The inner border of the heel and sole of the shoe on the affected side was raised to invert the foot and the child was permitted to go about normally. At night the affected leg was encased in a plaster-of-Paris boot from the toes to the upper thigh. This boot was replaced frequently, each time correcting the knock-knee as much as possible.

After one year under treatment, at which time the patient was lost sight of, the discrepancy in the length of the two legs had decreased fifty per cent. and the knock-knee had become very much less noticeable.

FOOT SUPPORT FOR USE WITH LEG TRACTION

BY CHARLES F. CLAYTON, M.D., FORT WORTH, TEXAS

Leg traction is useful in a variety of conditions. The problem of maintaining the foot in proper relationship to the leg during its use has long engaged the attention of those who have occasion to employ it.

Numerous attempts to solve this problem have been made, and some of the results published, but all, for one reason or another, have fallen short of meeting the requirements. Some months ago, with the idea of utilizing the traction force to provide the needed support, the apparatus shown in the accompanying illustrations was designed. The construction of this apparatus is shown in the perspective drawing, Fig. 1, and its application in Fig. 2. It will be seen to consist of three principal parts,—namely, frame, foot piece, and traction bail, the last two adjustably attached to the first.

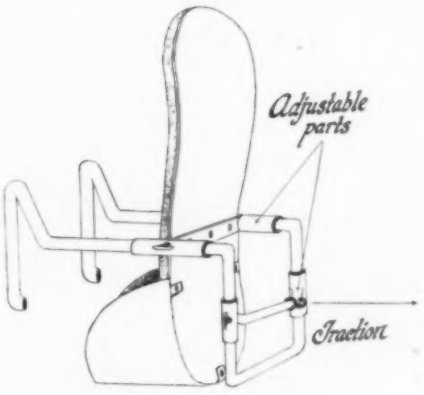

FIG. 1
Showing details of construction.

In applying the apparatus the foot piece is set at the lowermost point on the frame, and adhesive strips of proper width and sufficient length to reach from ankle to knee are attached to its upper extremities. While an assistant holds the foot piece snugly against the sole of the foot and stretches the skin of

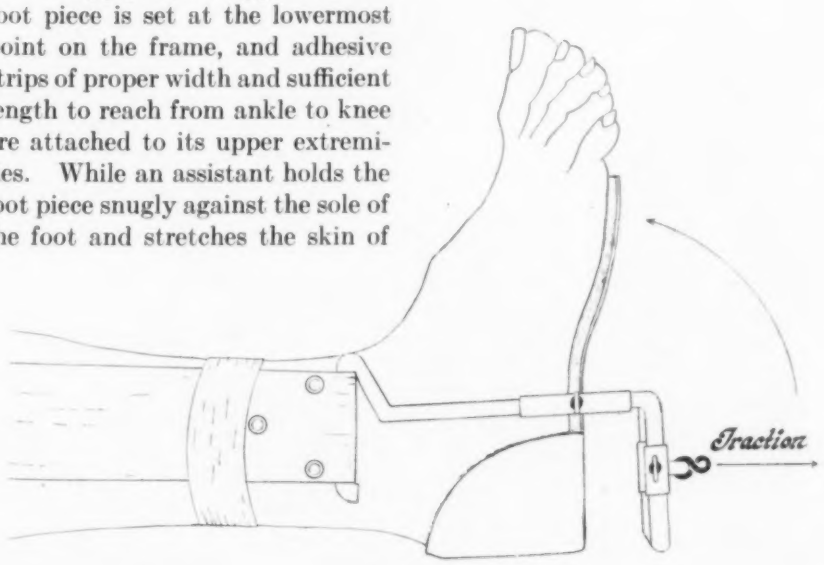

FIG. 2
Apparatus applied, showing how tilting force is exerted to support foot.

the leg downward, the adhesive plaster is applied to the skin, and reenforced by circular strips and a temporary layer of gauze bandage. Traction of the required amount is then applied by means of pulley and weight. The traction bail is adjusted backward on the frame to a point where the exact amount of tilting force necessary to maintain the foot at a right angle to the leg is exerted. Continuous traction results in a gradual slipping downward of the adhesive plaster on the skin. Consequent loss of support is prevented by adjusting the foot piece upward on the frame from time to time, keeping it always in snug contact with the sole of the foot. Troublesome slipping of plaster at the points of attachment to the apparatus will occur unless it is secured in some manner. The use of small metal paper fasteners, inserted with an instrument made for the purpose, provides a neat, simple, and efficient means of accomplishing this (Fig. 2). When so secured, the plaster may in many instances be used for several weeks without renewal.

Experience in the use of this appliance has shown that it meets satisfactorily all of the requirements for which it was designed. It is simple in application, extremely comfortable and efficient, providing automatically adequate, continuous support for the foot.

A DEVICE FOR THE RELIEF OF PAIN IN BURSITIS AT THE SHOULDER

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

Director of Roentgenology, New York Orthopaedic Dispensary and Hospital

In many cases of bursitis at the shoulder, pain is lessened or relieved by downward traction on the arm. The device described offers a means of applying such traction without interfering with motion or occupational activity of the patient.

Sheet lead one-eighth of an inch thick is used as a weight. It is cut

FIG. 1

six to eight inches long by two to six inches wide, the long axis fitting the circumference of the forearm near the elbow. About six by eight inches of lead (two pounds) is used for a patient who weighs 200 pounds, three by six inches (three-quarters of a pound) for a patient of 100 pounds. If the weight used causes fatigue, it is reduced about one-third after the first day.

The lead strip is bent over a three-inch pipe to form a tunnel. It is then covered with adhesive plaster to avoid soiling. A bandage is laid along the front of the forearm. The lead tunnel is applied over the bandage and pressed to fit the forearm snugly just below the elbow. The inferior end of the bandage is then brought up over the tunnel and knotted to the superior end. The free ends of the bandage are then passed about the arm just above the olecranon process and tied, not tightly. A strip of adhesive keeps the bandage from slipping over the olecranon process, which enables the bandage to hold the weight from slipping down the forearm. If the lead has been fitted snugly to the forearm it should not be necessary to encircle it with bandage.

This device is readily removed at night by slipping the knotted bandage over the olecranon process. It is easily reapplied by the patient. It gives quick relief and can be applied by the patient whenever pain occurs. It does not interfere with motion or with treatment of the condition by massage, diathermy, exercises, or other means. It has given great relief to the patients on whom it has been used.

The illustration shows the device applied. This is a large weight (six by six inches) and it has been padded with felt at the lower end to protect the radius.

AN IMPROVED CLAVICLE SPLINT

BY MYRON O. HENRY, M.D., MINNEAPOLIS, MINNESOTA

The adjustable clavicle splint presented herewith has been devised by the author to fulfill the traditional requirements of lifting the shoulder upward and backward, and the modern requirements of holding the shoulder outward and permitting free motion of the joints of the arm during the healing period. This splint maintains the *elevation* of the shoulder through an adjustable upright taking its support from a pelvic girdle which is held well in over the crest of the ilium. Any desired amount of elevation can be secured and maintained by the set-screw. Only two sizes of pelvic girdles are necessary to adapt this splint to any adult and elevation of the shoulder is secured from the pelvis. A very thick axillary crutch is used with a pressure pad against the anterior portion of the shoulder. The *backward* position of the shoulder is then secured by a loop of webbing, which is passed around the other shoulder and can be drawn up to pull the shoulder backward as desired. The thick axillary crutch virtually increases the diameter of the cone of the thorax and thus maintains the shoulder in an *outward* position. The crutch is held close in the

FIG. 1

Side view of improved clavicle splint. Note *elevation* of shoulder by adjustable bar from pelvic girdle fitted over iliac crest, and *backward* position of shoulder.

FIG. 2

Posterior view of improved clavicle splint. Note massive axillary pad maintaining *outward* position of shoulder, and strap to maintain *backward* position of shoulder.

apex of the axilla by a webbing strap about the chest at this level. The hand rest is attached to the upright by a set-screw, and can be set at any desired level.

The splint is not uncomfortable and it allows the patient to be ambulatory, fully dressed. Perfect alignment and correction of all shortening can easily be secured in this splint and the joints of the extremity remain entirely free throughout the healing period. The students whose fractured clavicles have been treated in this splint lost only one day from classes and gained perfect functional results. The free use of the arm permitted by this splint prevents atrophy and stiffness and thereby eliminates massage, physiotherapy, and other subsequent treatment.

Acromioclavicular dislocations, either complete or partial, can also be treated in this splint satisfactorily.

EMIL S. GEIST

EMIL S. GEIST

Dr. Emil S. Geist died suddenly at his home in Minneapolis on May 14, 1933, of heart disease. He had just returned from the meeting of the American Orthopaedic Association in Washington, D. C. Mrs. Geist and one daughter were returning by motor. His death leaves a distinct gap in the ranks of orthopaedic surgeons.

Dr. Geist was born in St. Paul, Minnesota, on May 8, 1878. He was graduated from the Medical School of the University of Minnesota in 1900 and served his internship at St. Joseph's Hospital, St. Paul. He became interested in orthopaedic surgery and spent three years in post-graduate study abroad in the clinics of Paris, Breslau, and Vienna where he was associated with Mikulicz, Sauerbruch, and Lorenz. Upon his return he entered the practice of orthopaedic surgery in Minneapolis, where he practised actively until his death. He was early interested in the development of the x-ray and brought the first x-ray machine to Minneapolis. In 1911 he married Augusta Ohage, daughter of Dr. Justus Ohage of St. Paul.

His name will always be remembered in connection with orthopaedic surgery in the Northwest. He was the founder, and enjoyed being called the father, of the Minnesota Orthopaedic Society. He served as head of the Orthopaedic Department of the Minneapolis General Hospital for many years. He was a member of the active staff of all the private hospitals in Minneapolis, and in 1928 was elected president of the Hennepin County Medical Society. The Minnesota Academy of Medicine elected him President in 1931.

He was a Fellow of the American College of Surgeons and was a very active member of the American Orthopaedic Association. He was greatly interested in establishing an international society of orthopaedic surgeons and was a charter member of the International Society of Orthopaedic Surgery, founded in 1930 in Paris. He made many contributions to the scientific literature and was particularly interested in the progress of orthopaedic surgery.

During the World War he served with distinction and great loyalty as Major in the Medical Corps of the Army. During a part of this service he was assigned to the duty of conducting a school of orthopaedic surgery for younger officers at Fort Oglethorp, and made it one of the best in the service. He had also the capacity of infusing enthusiasm into all of his classes, which was shown by the voluntary testimonials given to him at the time of completion of the courses.

Dr. Geist had an unusually active mind and was interested in many things. He loved music, literature, and outdoor life, and his familiarity with several languages added much to his versatility, and the larger opportunity for contacts made possible by this accomplishment influenced his point of view to a wider vision and to a larger horizon.

His genial character and interesting personality attracted the attention of many young men to his chosen specialty, and he was constantly encouraging them to further study and pointing out problems to be solved. Wherever he was, he was surrounded by friends, the numbers of which bear witness to his nature.

News Notes

The Congress of the **Czechoslovakian Orthopaedic Society**, scheduled for next September, has been postponed until 1934. The members will endeavor to attend the Congress at Poznan, Poland, in which Congress all branches of medicine and surgery are represented.

At the annual meeting of the **Milwaukee Orthopaedic Club** on April 21, Dr. Herman C. Schumm was elected President and Dr. L. D. Smith, Secretary.

Prof. Jan Zahradníček has been appointed Director of the Clinic of Orthopaedic and Children's Surgery opened in Prague on May 3.

Dr. Borivoje Gradojević, formerly Assistant in the Clinic of Surgery, has been appointed Docent of Orthopaedic Surgery in the University of Belgrade, Yugoslavia.

Alumni Day of the **Hospital for Joint Diseases** was held at the Hospital on Wednesday, May 3. An operating clinic and a dry clinic were presented by members of the Orthopaedic Service and by the staff of the General Surgical Service. Papers were also presented on "Diagnostic Observations on Some Abdominal Diseases" by Dr. Emanuel Libman, and "Present Day Trends in Orthopaedic Surgery in Light of Its Past History" by Dr. E. M. Bick.

There has recently been established in Brno, Czechoslovakia, a new State Orthopaedic Hospital Clinic, attached to the University. This Clinic was opened on March 17 and is equipped with 119 beds. The Chief of the Clinic is Prof. Dr. Bedřich Frejka of Brno.

At the opening of the new Merck Research Laboratory at Rahway, New Jersey, on April 25, the guest of honor was Sir Henry H. Dale, C.B.E., M.D., F.R.S., Director of the National Institute for Medical Research in London. Dr. Dale's address was on the subject "The Relation of Research in Universities to Research Supported by Industry".

A hospital of 150 beds has been opened at Brno with complete modern equipment, under the auspices of the Laborers' Injury Insurance Institution of Moravia, with Dr. T. Novák as Director.

The Rocky Mountain Orthopaedic Club held its regular meeting in Denver, Colorado, May 13, 1933, with Dr. Robert G. Packard presiding. The Rocky Mountain Orthopaedic Club was organized in September 1930 with the following members: Dr. S. Fosdick Jones, Dr. Robert G. Packard, Dr. Henry W. Wilcox, Dr. Atha Thomas, Dr. Charles Sevier, Dr. Hamilton I. Barnard, Dr. George K. Cotton, Dr. Melvin Black, of Denver, and Dr. J. Sims Norman of Pueblo. Meetings are held on the second Saturday of each month. Clinical cases are presented.

The preliminary program for the **Twenty-Eighth Congress of the Deutsche Orthopädische Gesellschaft** has been issued. The Congress will meet in Leipzig September 11 to 13, under the presidency of Prof. Dr. Fr. Schede. The principle subjects for discussion will be Orthopaedic Surgery and Rheumatism and The Conservative Treatment of Flat-Foot. Special consideration will be given to: (A) The Foot of the Small Child; (B) The Child at School and at Play; (C) The Foot of the Growing Child. Several papers will be presented on the various forms of arthritis. On the last day the members will present papers on various subjects.

The Fourth International Congress of Radiology will be held in Zurich, under the presidency of Prof. H. R. Schinz, from July 24 to 31, 1934. According to the "Rules and Regulations", the Congress may be attended by: (1) members of radiological societies in all countries; (2) persons introduced by such societies.

At the general meeting the following subjects will be considered:

X-Ray Diagnosis of Bone Tumors.
Vasography.
The Development of Pulmonary Tuberculosis as Seen Radiologically.
Radiation Treatment of Uterus Carcinoma.
Radiation Treatment of Malignant Tumors of the Mouth and Pharynx.
Radiation Genetics.
Mitogenetic Radiation (*Mitogenetische Strahlung*).
Structure Analysis.
Identical Physical Measurement of the Dose in X-Ray and Radium Treatment.
Hard Gamma Rays, Cosmic Radiation, Earth Radiation.
Short Wave Therapy (*Kurzwellentherapie*).

All radiological societies are requested to send as soon as possible a list of their members to the General Secretary, Dr. H. E. Walther, Gloriastrasse 14, Zurich.

At the Spring Meeting of the **British Orthopaedic Association** held at Cambridge on June 23 and 24, the program included the following lectures and demonstrations:

Factors in the Development of Skeletal Form. Dr. P. D. F. Murray.
Experiments *in vitro* on the Histogenesis of Cartilage and Bone. Dr. H. B. Fell.
The Repair *in vitro* of Embryonic Skeletal Rudiments after Experimental Injury. Dr. J. S. F. Niven.
The Development *in vivo* and *in vitro* of the Avian Patella. Dr. J. S. F. Niven.
The Control of Muscular Contractions by the Nervous System. Prof. Adrian.
Experimental Deformities in Healthy Animals. Dr. A. B. Appleton.
Vitamins and Bone Structure. Dr. Leslie Harris.
Relation of Epiphyseal Ossification to Nutrition and Absolute Size. Dr. A. B. Appleton.
Mobility of the Abdominal Viscera. Dr. Barclay.

The Second Congress of the **International Society of Orthopaedic Surgery** will be held in London, July 19 to 22, under the presidency of Prof. G. Nové-Josserand, of Lyon. The Secretary-General is Dr. J. Delchef, of Bruxelles. The meeting will be held at the headquarters of the Royal Society of Medicine, 1, Wimpole Street, London. The afternoon of July 19 will be given to the opening of the meeting and the general assembly of the members, and the evening to a reception by the President at the Langham Hotel, Portland Place.

On Thursday, July 20, the meeting will be opened by the President with an address on "The Orientation of Orthopaedic Surgery in General". Following this there will be

a discussion on "The Mechanism of the Joint Movements" by Dr. H. von Bayer, Heidelberg; Dr. Francesco Delitala, Venice; and Dr. Richard Scherb, Zurich. The afternoon will be devoted to clinical presentations and demonstrations in the hospitals, and the evening to a reception given by the College of Surgeons.

On Friday, July 21, "The Treatment of Tuberculous Coxitis" will be discussed by Dr. Philipp Erlacher, Graz; Dr. A. Maffei, Brussels; Dr. Melvin S. Henderson, Rochester, Minnesota; and Dr. Étienne Sorrel, Strasbourg. The afternoon will be occupied with operative demonstrations at the hospitals. In the evening a banquet will be held at the Dorchester Hotel, Park Lane.

On Saturday, July 22, the following subjects will be presented:

Arthroplasty of the Hip Joint. By Dr. Willis C. Campbell, Memphis, Tennessee.

Observations on Hypertrophic Osteopathies. By Dr. Charles Lasserre, Bordeaux.

Treatment of Fractures of the Spine. By Dr. Lorenz Böhler, Vienna.

A New Spinal Ankylosing Operation. By Dr. Fran Minář, Ljubljana.

Pathodynamics of Wrist and Finger Contractures. By Dr. Arthur Steindler, Iowa City, Iowa.

Arthrogryphis Multiple Congenita. By Dr. Walter G. Stern, Cleveland, Ohio.

Ganglionic Biopsy as a Means of Diagnosis in Tuberculous Osteo-Arthritis. By Dr. José Valls, Buenos Aires.

The Forty-Sixth Annual Meeting of the American Orthopaedic Association was held in Washington, May 8 to 11, under the presidency of Dr. Arthur Steindler. The clinical and scientific sessions were held at the Walter Reed General Hospital.

The first morning was occupied with clinical presentations by members of the Association in Washington and by members of the Staff of the Walter Reed General Hospital. After inspection of the Hospital, under the guidance of the Army Staff, the afternoon was open to the members and guests to occupy themselves at will.

The President's reception to members and guests was held at the Army and Navy Club on Monday evening, May 8.

On Tuesday, May 9, the following papers were presented:

Chronic Osteomyelitis Presenting Distinct Tumor Formation Simulating True Osteogenic Sarcoma.
Dr. George R. Elliott, New York, N. Y.

Backache.
Dr. Joel E. Goldthwait, Boston, Massachusetts.

A New Operation for Recurrent Dislocation of the Jaw.
Dr. Leo Mayer, New York, N. Y.

Simple Method of Treatment of Many Metatarsal Disabilities.
Dr. J. T. Rugh, Philadelphia, Pennsylvania.

Sciatic and Sacro-Iliac Disease.
Dr. Albert Freiberg, Cincinnati, Ohio.

Prespondylolisthesis: Its Roentgenographic Appearances and Clinical Significance.
Dr. S. Kleinberg, New York, N. Y.

Data on Fracture Healing: Series of 2000 Rats.
Dr. Merrill K. Lindsay, New Haven, Connecticut.

Report on End Results of Tuberculous Joints.
Dr. Z. B. Adams, Boston, Massachusetts.

Original Features in Arthroplasty of the Elbow.
Dr. Fred H. Albee, New York, N. Y.

Presidential Address.
Dr. Arthur Steindler, Iowa City, Iowa.

Chronic Synovitis of the Knee with Persistent or Recurring Effusion and of Undetermined Etiology.
Dr. A. Bruce Gill and Dr. T. E. Orr, Philadelphia, Pennsylvania.

A Study of 100 Cases of Subdeltoid Bursitis.
Dr. Mark H. Rogers, Boston, Massachusetts.

Acute and Chronic Forms of Bursitis.
Dr. Charles E. Sevier, Denver, Colorado.

Fusion of Tuberculous Hips.
Dr. R. I. Harris, Toronto, Canada.

On Tuesday evening, a reception and address were given at Auditorium National Museum by the President of the Congress of American Physicians and Surgeons, Dr. Harvey Cushing, of Boston.

On Wednesday, May 10, the scientific session was continued at the Walter Reed General Hospital, and the following papers were presented:

Mechanical Instability of the Shoulder Joint: In Relation to Prevention and Treatment of Painful Shoulders.
Dr. Lloyd T. Brown and Dr. John J. Kuhns, Boston, Massachusetts.

The Relation of Blood Chemistry to the Locomotor System.
Dr. Russell M. Wilder, Rochester, Minnesota (by invitation).

Tendon Transplantations in the Upper Extremity in Cases of Poliomyelitis.
Dr. Frank R. Ober, Boston, Massachusetts.

Block Osteotomy for Bowed Femur.
Dr. Edwin W. Ryerson, Chicago, Illinois.

Description of Operative Procedure for Improvement of Cases with Quadriceps Paralysis.
Dr. C. C. Yount, Pittsburgh, Pennsylvania.

Pelvic Relaxation During Pregnancy.
Dr. Philip D. Wilson, Dr. D. Abrahamson, and Dr. S. Roberts, Boston, Massachusetts.

Transplantation of Astragalus and Carpal Navicular Bone.
Dr. D. B. Phemister and Dr. W. S. Keith, Chicago, Illinois.

A New Method of Osteotomy for Correction of Long Standing Bony Deformity at the Knee.
Dr. Armitage Whitman, New York, N. Y.

A Study of Torsional Deformity of the Lower Extremity with Special Regard to Etiology and Clinical Significance.
Dr. I. William Nachlas, Baltimore, Maryland.

On Thursday morning, May 11, the following papers were presented:

Nerve Injuries Associated with Fractures.
Dr. Dean Lewis, Baltimore, Maryland (by invitation).

Knee Joint Instability and Crucial Ligament Injury.
Dr. Arthur Krida, New York, N. Y.

Fractures of the Condyles of the Humerus.
Dr. J. S. Speed, Memphis, Tennessee.

Fracture of the Ulna with Dislocation of the Head of the Radius.
Dr. Samuel R. Cunningham, Oklahoma City, Oklahoma.

Treatment of Fracture of the Tibia and Fibula: Kirschner Wire Method.
Dr. C. F. Eikenbary, Seattle, Washington.

A Study of Old and Recent Fractures of the Ankle.
Dr. M. S. Henderson, Rochester, Minnesota.

On Wednesday afternoon the members participated in the General Assembly of the Congress of American Physicians and Surgeons.

The annual dinner for the members and guests of the Association was held in the Mayflower Hotel on Wednesday evening at eight o'clock.

At the business session, following the close of the scientific meeting, on Thursday, May 11, five orthopaedic surgeons were elected to membership:

R. C. Lonergan, M.D., Evanston, Illinois.
E. B. Mumford, M.D., Indianapolis, Indiana.
R. P. Schwartz, M.D., Rochester, New York.
S. F. Stewart, M.D., Los Angeles, California.
W. K. West, M.D., Oklahoma City, Oklahoma.

And the following were elected Corresponding Members of the Association:

Mr. H. A. T. Fairbank, London, England.
Prof. René Froelich, Nancy, France.
Prof. Patrik Haglund, Stockholm, Sweden.
Prof. É. Sorrel, Strasbourg, France.
Prof. Henning Waldenström, Stockholm, Sweden.

Two members were placed on the Emeritus List:

J. P. Lord, M.D., Omaha, Nebraska.
Sydney Cone, M.D., Baltimore, Maryland.

The following officers were elected for the ensuing year:

President: Melvin S. Henderson, M.D., Rochester, Minnesota.
President-Elect: DeForest P. Willard, M.D., Philadelphia, Pennsylvania.
Vice-President: Arthur T. Legg, M.D., Boston, Massachusetts.
Treasurer: John L. Porter, M.D., Evanston, Illinois.
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.
Executive Committee: Arthur Steindler, M.D., Iowa City, Iowa.
Membership Committee: Robert I. Harris, M.D., Toronto, Canada.
Program Committee: John C. Wilson, M.D., Los Angeles, California.

Delegates to the Congress of American Physicians and Surgeons: J. Torrance Rugh, Philadelphia, Pennsylvania. Alternate: Robert D. Schrock, M.D., Omaha, Nebraska.

Delegates to the American College of Surgeons: D. B. Phemister, M.D., Chicago, Illinois, David Silver, M.D., Pittsburgh, Pennsylvania, and W. B. Owen, M.D., Louisville, Kentucky.

The next meeting of the Association will be held in Rochester, Minnesota, under the presidency of Dr. Melvin S. Henderson.

Current Literature

SURGICAL ANATOMY. By C. Latimer Callander, A.B., M.D., F.A.C.S. With a Foreword by Dean Lewis, M.D., Sc.D., LL.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1933. $12.50.

This book, as the title implies, is a topographical anatomy, written from a surgical point of view, and represents in the main material which has been gathered from the original investigations of the authors. The anatomy has been studied definitely with the object of serving as an aid and guide in the surgical treatment of the affections of the various parts of the body. It is comprehensive, including all structures.

The authors make no attempt in this work to direct the surgeon in his treatment or in his technique, except to furnish him with anatomical data, particularly the topographical, anatomical data, which will serve not only in the details of operation, but in forming his judgment on procedures to undertake.

The book is divided regionally and with special consideration of the structure in each section, so that the information desired on any special anatomical structure or region can be easily and quickly found. The various approaches to the underlying structures are given without detail, but indicate by the description and illustrations the structures to be found in different steps of the operation, as well as those structures to be avoided. The position of the underlying parts is also described and indicated by illustrations which serve as a guide to the position and character of the incision for the special approach. The steps in these avenues of entrance are illustrated with excellent drawings, most of which are made from original dissections by the authors.

A great deal of attention has been paid to the discussion of the bones and joints with those anatomical considerations which are of interest because of their near relation to these structures and to the various portions which are known to be the sites of injury and disease. The different avenues of approach to these and the method of exposing the parts which are opened up are well illustrated, many times almost profusely so. The relation of the muscular structures to their tendinous attachments is given a great deal of attention and, aided by the photographs, serves to explain the mechanism of many of the distortions associated with fractures as well as many of the maladjustments often found in old cases. This portion of the book will be found particularly valuable by the orthopaedic and traumatic surgeons who occupy themselves with the affections and injuries both of the bones and joints, and the entire work will be a great aid to the surgeon of lesser experience and the means of refinement of technique to the more experienced surgeon.

THE SIGNIFICANCE OF PHOSPHORIC ESTERS IN METABOLISM. By Robert Robison, Ph.D., D.Sc., F.R.S. (Christian A. Herter Lectureship on Pathological Chemistry, New York University.) New York, The New York University Press, 1932. $2.00.

This short monograph should be of interest and help to any practitioner of medicine who is interested in the physiology and pathology of bone and bone diseases.

The first chapter is rather technical and requires a certain knowledge of chemistry in order to thoroughly understand it. It concerns "The Occurrence of Phosphoric Esters in Nature". It illustrates how work in the fundamental sciences may at any time become applicable in furthering our knowledge of physiology.

The author was originally interested in the phosphoric esters of alcohol fermentation. In studying the hydrolysis of hexos monophosphate by various enzymes, he found that, when hydrolysis of soluble calcium salts occurred, the liberated inorganic phosphate was precipitated as the insoluble calcium phosphate on the side of the vessel. This finding suggested to the author that such a mechanism might be concerned with the

deposition of calcium salts in the bone. Further investigation proved that such a mechanism did occur in the calcification of cartilage and bone.

As a result of such well thought out and well controlled experimentation, we now know that the enzyme in bone and cartilage called phosphatase plays this all-important rôle in calcification. Methods for its determination in blood have been worked out and are being used in the clinic as a diagnostic procedure in differentiating bone diseases. The highest values are obtained in generalized osteitis fibrosa cystica, rickets, and Paget's disease.

Much of the experimental work presented was done by the author and his colleagues. Certainly this book should be read by every orthopaedic surgeon.

PERIPHERAL NERVE INJURIES. By Lewis J. Pollock, M.D., and Loyal Davis, M.D. New York, Paul B. Hoeber, Inc., 1933. $10.00.

The authors have presented in this volume a very carefully prepared treatise on the subject of nerve injuries and their treatment, particularly the surgical aspect. The book confines itself to this special subject of injuries of peripheral nerves, but goes into great detail in all branches of the subject. The first thirteen chapters are devoted to the methods and means of examination of nerve injuries, as well as a description of the equipment which is necessary for such examination; one chapter deals with the development of the peripheral nervous system, particularly in its bearing on diagnosis and treatment. The next few chapters are devoted to pathological nerve lesions, degeneration of nerve, and methods of nerve repair, with full description of surgical technique, the various methods of suture, and the necessary after-care,—including exercises, etc., for the regeneration of nerves and muscular power.

The book then takes up the injury and treatment of the more important nerve trunks, treating each nerve in a separate chapter: its special injuries; the results of injury in distribution of the paralysis, both motor and sensory; deformity; methods of examination; and, particularly, the means and the technique of treatment. The trophic disturbances and the deformities following nerve injury are also considered.

The book presents the personal experience—evidently a large experience—of these two men, and, therefore, is largely individual, which adds to the value, but, as stated in its preface, the literature has been thoroughly consulted and the opinions of other observers have been used. For those having to deal with the very difficult subject of nerve repair, this volume will be found of great value.

OPERATIVE SURGERY. By Warren Stone Bickham, M.D., Phar.M., F.A.C.S., and Calvin Mason Smyth, Jr., B.S., M.D., F.A.C.A. Philadelphia and London, W. B. Saunders Co., Vol. VII, 1933. $10.00.

As the result of an excellent plan, the seventh volume of Operative Surgery is issued, and gives, after the appearance of the first six volumes, recognition and opportunity for discussion of the many advances which have taken place during this time. In operative surgery these changes are largely confined to the opening of new fields for surgical procedures, and the development of new and important methods of technique in the already established procedures. By reference to the original volumes, this work is able to confine itself to the discussion of essentials of the more recent methods without entering too greatly into detail, which is unnecessary to that surgeon who is fitted for the surgical treatment of these conditions.

The changes in the technique and improved methods of general surgical procedure which have been developed in these latter years, many of which are the result of new and more accurate laboratory methods, are fully discussed. This is a valuable portion, for it is applicable to all departments of surgery.

The subject of anaesthesia, with new methods and improved technique, is given special consideration, which is wise, for anaesthesia has become a very important development in surgical procedures.

The enlargement of the field of bone and joint operative surgery, which has been made possible by the better understanding of those joint conditions shown by the x-ray, is given special attention in this book. Particularly is this evident in the treatment of fractures and the better results which are obtained because of the more accurate knowledge of the conditions with which the surgeon is dealing, and the facilities for observation during the course of healing.

The other departments of surgery have received in this volume the same careful treatment, confining the description to those methods which are more advanced and to which the experienced surgeon will naturally turn. It is a book which will be of much value even to those who do not possess the first six volumes.

THE ADJUSTMENT OF MUSCULAR HABITS. By Lieut. Col. James K. McConnel, D.S.O., M.C. London, H. K. Lewis and Co., Ltd., 1933. 4s. 6d. net.

This small book of 126 pages is rather an unusual presentation of the experience of an observer who has evidently had a large personal experience in the methods of physical training, physical adjustment, etc. The book is unique in many respects, particularly in its scope in dealing with this subject which ordinarily is more or less limited. The individual and his peculiarities, particularly the influence of old habit, are given consideration. The necessity of developing the proper spirit of cooperation, and the need for the careful study of the temperament of the individual, in every case, in order to obtain the best results are emphasized.

The term "adjustment", rather than "posture" or "malposition", is intelligently employed, and much more expresses the point of view and the method of attack which is advised by Mr. McConnel. The careful detail which is emphasized in treatment of these conditions, and the necessity for individual attention, may be followed with benefit by those engaged in these forms of therapy.

AMERICAN AND CANADIAN HOSPITALS. Edited by James Clark Fifield, with the cooperation of the American Hospital Association. Minneapolis, Midwest Publishers Company, 1933. $10.00.

This large volume offers to the public valuable information in regard to hospitals in the United States and Canada. In this book practically all hospitals are listed, and the necessary information in regard to their foundation, size, equipment, standing, etc., is given, as well as the medical and surgical staffs and the relation to the community which they serve. In addition to this there is presented a list and an account of practically all the associations dealing with hospitals—social service, nursing, Red Cross, etc.—with a history of their organization and development, their official personnel, and the objectives to which they are devoted; also, as an appendix, is given in the same manner a list of the various associations, funds, foundations, etc., which are engaged in hospital and welfare service.

The book is a large one, composed of 1560 pages, confines the material to this practical information, and will be found of value as a reference book by all those who are in need of information of this character.

REPORT ON THE STRANGEWAYS COLLECTION OF RHEUMATOID JOINTS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS. By R. Lawford Knaggs, M.C. (Cantab.), F.R.C.S. Bristol, John Wright and Sons Ltd., 1933. (British J. Surg., XX, 113, July 1932; 309, Oct. 1932; 425, Jan. 1933.)

This report is a welcome contribution to do credit and honor to the unusual work which was begun and carried on by Dr. Strangeways in Cambridge. The assembling of this material was begun by this unusually intelligent and honest worker when the subject of arthritis offered little inducement, either in result or pecuniary reward, to the time and

effort spent in pursuit of this subject. This collection, which was the work of the larger part of his life, testifies to his foresight and to his enthusiasm. At the death of Dr. Strangeways, the Collection was given to the Royal College of Surgeons, under the care of Mr. Knaggs. The specimens have had a very thorough study by Mr. Knaggs, who now presents the results of this study in a form of great practical value to the student of arthritis.

The characteristics of the different types of arthritis are considered and the intimate relation between osteo-arthritis and rheumatoid arthritis as regards different phases or stages of the same infection is discussed; and also the conditions found in gout and the neuropathic changes are very thoroughly illustrated.

Four conclusions are drawn as to the factors causing the different rheumatoid conditions:

"1. The circulation of toxins is probably the essential and underlying factor in all four.

"2. The measure of the vitality of the joint tissues is shown by their resistance to the toxic influence, and is the deciding factor in the evolution of osteo-arthritis and rheumatoid arthritis.

"3. A metabolic factor is of decisive importance in gout; and

"4. A nervous factor in Charcot's disease, but in both these conditions toxins and tissue vitality take their full share."

CHRONIC ARTHRITIS AND FIBROSITIS: DIAGNOSIS AND TREATMENT. By Bernard Langdon Wyatt, M.D. Baltimore, William Wood and Co., 1933. $3.50.

Following an introduction that recapitulates the mortality statistics in arthritic diseases, cites the influence of age, sex, etc., on its incidence and the effects of social conditions, geographic distribution, and morbidity figures upon the mortality, and discusses how important it is to the general practitioner that these diseases be recognized and treated by him, thus avoiding the danger of falling into the hands of incompetents, the author devotes a chapter to nomenclature, pathology, and etiology. The pathology is largely quoted from Dr. Allison's monograph. He adopts the same classification that he followed in his earlier book, except that he places gout among metabolic disturbances and devotes considerable space to a discussion of the various tests used in the study of chronic infectious arthritis to establish its allergic relations in the matter of treatment. Emphasis is laid upon diet and building up the patient's resistance. All forms of physiotherapy find a place in the author's armamentarium, including colonic irrigation, various electrical currents, air currents, water baths, and douches. Vaccine therapy comes in for discussion. In addition to the frankly arthritic lesions he includes a class which he designates as chronic fibrositis, to cover the near-arthritis, apparently. A good deal more detail is gone into in this book as far as treatments are concerned than in the former, with the result that the general impression is not so good. The appeal for a composite therapy savors too much of just the things that need to be avoided, which had no place in the earlier work.

REPORT ON SIXTH INTERNATIONAL CONGRESS OF MILITARY MEDICINE AND PHARMACY—The Hague, Netherlands, June 1931—Report of Commander William S. Bainbridge, M.C., U.S.N.R. Washington, United States Government Printing Office. $1.00.

The official delegates, representing thirty different countries, who attended the Congress are listed; its officers and the members of the permanent committees are stated and the subjects decided upon for consideration at the Seventh Congress are set forth.

Subjects reported on at the Congress include:

1. Recruiting, Training and Advance Training of Military Medical Officers and Pharmacists.

This subject is reported on officially by some six leading nations, and the methods

carried out by each explained. Communications from leading medico-military men of various other nations on this subject are included, and a report after thorough personal study of these methods by two medical officers is made, conclusions drawn, and recommendations set forth.

2. The Psychoneuroses of War; The Immediate and Remote Effects of War on the Nervous System of Combatants and Non-Combatants.

The Congress recommended a neuropsychiatric center for the Army, for sorting, serious cases evacuated, retention in the Army area of others, a regional center in every region in the interior, for a second sorting and for classification; major psychopaths interned in asylums,—transitory disturbances to be treated there and patients requiring more prolonged treatment, in secondary regional centers.

3. Methods of Hemostasis on the Battlefield; Standardization of First-Aid Material and the Mode of Application.

4. Preparation and Storage of Medical Ampoules.

5. The Sequelae of War Wounds of the Teeth and Inferior Maxilla; Their Treatment.

Collaboration of a dental specialist and a surgeon are essential from the start. Initial immediate treatment and immobilization are essential. Bone infection is to be prevented by early extraction, debridement, and fixation. Non-union and loss of substance are treated by bone graft, malunion by osteotomy and correction of deformity. Metallic osteosynthesis is contra-indicated. Temporomaxillary ankylosis is treated by arthrotomy and mobilization apparatus. Scar excisions and plastic repair of soft tissues are indicated. The psychological state of the individual with a facial deformity should never be lost sight of.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Journal de Médecine de Bordeaux et du Sud-Ouest. Bordeaux, Vol. CX, Nos. 2 and 8, January 20, and March 20, 1933.

Bulletin of the National Tuberculosis Association. Vol. XIX, Nos. 1, 2, 3, 4, and 6, January, February, March, April, and June, 1933.

Norsk Magasin for Laegevidenskapen. Oslo, Norway, Vol. XCIV, Nos. 1, 2, 3, 4, 5, and 6, January, February, March, April, May, and June, 1933.

Programm des 48. Fortbildungskursus der Wiener Medizinischen Fakultät. Vienna, 1933.

The Johns Hopkins University Circular, School of Hygiene and Public Health, Catalogue and Announcements for 1933–34. New Series, 1933, No. 5. Baltimore, The Johns Hopkins Press, 1933.

Die Knotenbildungen des Darmes. By K. E. Kallio. Helsinki, 1932. Acta Chirurgica Scandinavica, LXX, Supplementum XXI.

Slovanský Sborník Ortopedický. Brno, Czechoslovakia, Vol. VII, No. 6, 1932, and Vol. VIII, Nos. 1 and 2, 1933.

*Physiological Effects of Radiant Energy. By Henry Laurens. New York, The Chemical Catalog Company, Inc., 1933.

*History and Source Book of Orthopaedic Surgery. By Edgar M. Bick, M.A., M.D. New York, The Hospital for Joint Diseases, 1933.

*Massage and Remedial Exercises in Medical and Surgical Conditions. By Noël M. Tidy. Baltimore, William Wood and Company, 1933.

*Das Wesen der Schwedischen Massage und ihre Anwendung Besonders auf dem Gebiete der Orthopädie. By Dr. Konrad Port. Beilageheft, Zeitschrift für Orthopädische Chirurgie, LIX. Stuttgart, Ferdinand Enke, 1933.

* To be reviewed in a later issue.

The Children's Hospital of Winnipeg, Twenty-Fourth Annual Report. Winnipeg, 1932.

Acta Rheumatologica. Rotterdam, Holland. Vol. V, No. 16, February 1933.

The Wellcome Research Institution, Exhibits at the Chicago Exposition. London, The Wellcome Foundation Ltd., 1933.

Merck Research Laboratory, Report of Dedication, April 25, 1933. New York, 1933.

Minneapolis General Hospital, Annual Report for the Year 1931. Parts I, II, and III, Minneapolis, 1933.

In commemoration of his sixtieth birthday, two large volumes (LXXI and LXXII) of the *Acta Chirurgica Scandinavica* were dedicated to Prof. Einar Key of Stockholm. Most of the seventy articles were contributed by Scandinavian friends and admirers. Such names as Payr, Sauerbruch, Eiselsberg, and Kirschner appear in the author's index, however, and there are several American contributors. The frontispiece of the first volume is an appropriate photograph of Prof. Key. In addition to the formal dedication there are numerous personal tributes in the papers themselves.

Über Schäden an der Epiphysenfuge bei Operativer Behandlung von Fracturen am Unteren Humerusende (Injuries of the Epiphysis with Operative Treatment of Fractures at the Distal End of the Humerus). Ernst Bergenfeldt. *Acta Chir. Scandinavica*, LXXI, 103, 1932.

Contrary to the view commonly expressed in the literature, a careful analysis of seventeen cases showed no growth disturbance of the distal end of the humerus, two to eleven years after nails had been driven through the epiphysis in the course of open reduction of fractures. In three cases there was premature synostosis. A varus position in six was attributed to imperfect reduction.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Studien über die Gabelsprengung im Fussgelenk (Studies of Separation of the Ankle Mortise). Patrik Haglund. *Acta Chir. Scandinavica*, LXXI, 280, 1932.

Separation of the lower ends of the tibia and fibula may be diagnosed by x-ray if an exact technique is used. Rotation of as little as ten degrees will vitiate the reading. A simultaneous symmetrical exposure of both ankles, with the feet close together in slight internal rotation, gives the most accurate reading. The central ray must fall exactly perpendicular to a line between the ankle joints. Separation is fairly common in severe sprains and fractures. Fortunately it usually disappears under the proper treatment. Persistent separation leads to a flail joint, traumatic flat-foot, and considerable disability.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

De la Transplantation d'un Fragment Osseux pour Remédier aux Luxations Récidivantes de l'Épaule; Constations et Résultats Opératoires (Transplantation of a Bone Graft for Recurrent Dislocation of the Shoulder). S. Hybbinette. *Acta Chir. Scandinavica*, LXXI, 411, 1932.

On the basis of twenty-two cases operated upon, the writer emphasizes the importance of damage to the labrum glenoidale and rim of the glenoid, as well as to the joint capsule, in the causation of recurrent dislocation of the shoulder. A bone graft from the tibia or crest of the ilium was placed in a periosteal pocket close to the rim of the glenoid, where the latter had been damaged or the capsule torn. Fixation of the graft was by reefing the capsule over it. The arm was kept in a sling and during the third week gentle active motion started. There were no recurrences. In only two cases was the mobility of the joint reduced. Numerous photographs are submitted in proof of the excellence of the results.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Ueber die Habituelle Luxatio Sternoclavicularis und eine Neue Operative Behandlungsmethode Derselben (Habitual Sternoclavicular Dislocation and a New Method of Operative Treatment). Sten von Stapelmohr. *Acta Orthop. Scandinavica*, III, 1, 1932.

From the study of thirty-six cases—three his own, two unpublished cases supplied by Dr. Nilsonne, and thirty-one from the literature—the writer classifies subluxations and dislocations of the clavicle on the sternum as presternal (common), suprasternal, and retrosternal; and as follows:

Congenital:—One proved case. Nine were claimed but not proved. Trauma at birth was not ruled out. (Eight classified below.)

Acquired:—Bilateral symmetrical luxations.

Six traumatic.

Ten spontaneous (doubtful congenital predisposition).

Unilateral luxations.

One traumatic.

Seventeen spontaneous (including slight trauma).

Except for the few congenital cases and unilateral traumatic cases, the age at which the dislocation was evident varied between eight and twenty years. Females predominated nineteen to eight.

Retrosternal and suprasternal dislocations should be manipulated into the presternal type of dislocation which often inconveniences the patient very little. If operation is necessary the disc should be freed from its sternal or clavicular attachment, removed, and the reduction of the joint temporarily maintained by steel pins. The articular disc is sewed over the anterior aspect of the joint as a permanent reenforcement. The method was used by the writer in a bilateral case in 1928.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Ueber Gonitis Incertae Causae Inbesondere Synovitis Chronica "Simplex", unter Besonderer Berücksichtigung des "Rheumatismus Tuberculosus-Poncet" und Fällen von Synovitis mit Ausgesprochener Fleckiger Atrophie. Halfdan Sundt. *Acta Orthop. Scandinavica*, III, 97, 1932.

This second article by Dr. Sundt on the subject of chronic gonitis deals primarily with the non-tuberculous lesions, which comprised 115 (thirty-five per cent.) of 329 cases reported. In sixty-five of these no definite diagnosis was possible. In twenty-two cases, of which six were children, the disease was bilateral but syphilis was ruled out. In the thirty-five of these cases in which the knees were explored, no microscopic evidence of tuberculosis could be found. Clinically tuberculous or syphilitic synovitis, osteo-arthritis, and osteomyelitis were variously imitated. Trauma and infection are important etiological factors. In half of the cases there was a history of trauma. Focal infection of tonsils, teeth, ears, nose, skin, or intestinal tract probably plays an etiological rôle. In some cases, especially the bilateral involvement of females at puberty or the climacteric, there is a constitutional or endocrine factor.

The synovial changes seem to be primary and the osseous, secondary. The x-ray may reveal an extreme patchy atrophy of the bones without clinical variation from the general run of cases.

Conservative treatment, including removal of foci of infection, correction of endocrine dysfunction, and x-ray therapy, should be tried first, but synovectomy will occasionally be necessary. Ten of the eleven total synovectomies gave very good results. Partial synovectomy seems to have a beneficial effect.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Prophylaktische Kontracturbehandlung (Prophylactic Treatment of Contractures). V. Rienke. *Acta Orthop. Scandinavica*, III, 262, 1932.

This comprehensive monograph on contractures comprises an historical and a physiological consideration of muscle tonus, an experimental study of functional and

organic contractures, and the description of a mobilizing apparatus with summaries of fifty-six cases in which it was used.

From the results of immobilizing the knee joints of guinea pigs and rabbits, the writer concludes that:

1. Functional contractures (those which disappear under anaesthesia) arise after immobilization for as short a time as half an hour.
2. Functional contractures disappear under anaesthesia but return after awakening.
3. Organic contracture may appear after two to three days of immobilization.
4. The duration of a contracture is not entirely relative to the duration of immobilization, but depends also on variations in the animals and the thoroughness of fixation.
5. Increase in tonus of a muscle is produced by fixation in the *relaxed* position.

Organic contractures are primarily due to muscle shortening and secondarily to capsular changes. The *irritation of function* is considered important in preventing them. Motion should be started on the first day, but it must not increase an existing inflammatory reaction, or cause pain or spasm. Apparatus must not interfere with dressing of wounds. To this end a worm gear operated by the patient has been adapted to the immobilization of infections, traumatic and postoperative joint conditions. Movement is so gradual as to be imperceptible to the patient. The application to various joints is described and illustrated by line drawings and case summaries.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Idiopathic Osteopsathyrosis. Lowell S. Goin. *Am. J. Cancer*, XVII, 668, Mar. 1933.

The author distinguishes three clinical entities,—osteogenesis imperfecta, hereditary osteopsathyrosis, and non-hereditary idiopathic osteopsathyrosis.

The first is characterized by imperfect development of membranous bones, the occurrence of intra-uterine fractures, a high degree of mortality, and frequent fractures of the cranial bones.

In idiopathic osteopsathyrosis the membranous bones are seldom if ever affected, fractures do not usually occur before the middle of the second year, and the patients do not die of the disease. In addition, the hereditary form of the disease presents the characteristic blue sclerae.

Various theories of the etiology of the conditions are reviewed, with the conclusion that none of them has been substantiated.

In addition to the extreme susceptibility to fractures, osteopsathyrosis is characterized by a typical shape of the head, which exhibits bilateral increase in diameter and unusual prominence of the frontal and occipital bones. There are also likely to be attacks of profuse sweating, and protruding abdomen is a typical feature. Fractures may occur in any of the bones, although the most common are the humerus and femur. The disease is self-limited, subsiding at about the time of puberty.

The roentgenographic findings are characteristic, with normal epiphyses and slender and irregular diaphyses, which have very thin cortices. Pathological examination of the bone confirms the thinness of the cortex, with imperfect haversian system and ill defined medulla.

In regard to treatment, the author recommends high calcium diet combined with viosterol or heliotherapy, accompanying careful treatment of the local fracture and protection from other fractures.

The author's series comprises eleven cases, one of which is reported in detail, and there are numerous photographs and roentgenograms illustrating typical deformities.—*Grantley W. Taylor, M.D., Boston, Massachusetts*

Multiple Myeloma. A Report of Four Cases. Ernest Scott, F. M. Stanton, and Mary Oliver. *Am. J. Cancer*, XVII, 682, Mar. 1933.

The authors review briefly the history of the disease and the etiological and clinical

features. No new data are brought forward on these subjects. There is a careful review of the microscopic characteristics of the tumor and a recapitulation of the various theories of histogenesis. They conclude that the tumor cell is a derivative of the reticular cell of the hemopoietic tissues. They have collected thirty recent cases from the literature to add to the group collected by Geschickter and Copeland in 1928, and in addition report in detail, with photomicrographs, five cases from their own autopsy series.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

Familial Multilocular Cystic Disease of the Jaws. William A. Jones. *Am. J. Cancer*, XVII, 946, Apr. 1933.

The author reports the existence of multiple cystic tumors of the jaws in three children of one family, with photographs, roentgenograms, and photomicrographs of an enlarged lymph node removed for diagnosis. Evidence of the process became apparent toward the end of the second year, and was well established shortly thereafter. The condition in the oldest child (aged six) suggests that regression may be in process. In addition to the malformed jaws, with hard palpable masses and wide alveolar ridges, there are derangements in the dentition and extensive enlargements of the submaxillary lymph nodes. The roentgenograms show multiple circular translucent areas with bony septa. The lymph node sections show hyperplasia with fibrosis and focal collections of endothelial cells.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

The Radiosensitiveness of Tumors Derived from Cartilage. Arthur U. Desjardins. *Am. J. Cancer*, XVIII, 15, May 1933.

The author again discusses the diagnostic importance of sensitivity to radiation therapy in bone tumors. He reports in detail a tumor of the femur in a young boy, which presented the onion-skin lamellar arrangement of new bone in the roentgenogram, considered typical of Ewing's tumor. Radiation therapy caused some temporary regression in the growth, less marked than that occurring in cases of Ewing's tumor. Subsequent amputation confirmed the diagnosis of osteogenic sarcoma, tending to differentiate toward cartilage. Another case, in which the tumor was apparently a chondroma of the pubis, was likewise benefited somewhat by radiation therapy. The author concludes that bone tumors derived from cartilage, in respect to their susceptibility to radiation, are intermediate between solitary endothelioma and osteogenic sarcoma.—*Grantley W. Taylor, M.D., Boston, Massachusetts*

El Tratamiento de las Osteomielitis y Fracturas Complicadas por el Metodo de Orr (Orr's Treatment in Osteomyelitis and Compound Fractures). Alberto Inclán. *Anales de Cirugia* (Habana), IV, 321, 1932.

Prof. Inclán presents his conclusions drawn from five years' experience with Orr's method in the treatment of osteomyelitis and compound fractures. Of the ninety-six cases treated by this method, fifty-two were of chronic osteomyelitis; eleven of acute osteomyelitis and fourteen of old osteomyelitis, following compound fractures; seventeen of recent compound fractures; one of pyogenous arthritis; and one of an infected wound. The conclusions are as follows:

1. Orr's treatment is considered the method of choice for the treatment of infectious osteomyelitis and of compound fractures treated six hours or more after the trauma.
2. Healing time is diminished, thereby reducing pain and discomfort for the patient, saving time and supervision for the surgeon, and reducing the cost of material to the institution.
3. The marked change in the general condition of these patients and their rapid return to normal speaks clearly in favor of the attenuation of the virulence of the infecting bacteria and of the clinical sterilization of the wound.
4. Reinfections and sinus formation are exceptional when using this method.

5. Foul odor is the greatest inconvenience of this treatment, as it produces in some cases vomiting and anorexia. Even the addition of peruvian balsam to the vaselin did not modify the condition in the cases in which it was employed.

CHONDROMA OF THE INTERVERTEBRAL DISKS. B. J. Alpers, F. C. Grant, and J. C. Yaskin. *Ann. Surg.*, XCVII, 10, 1933.

Extensions of the intervertebral disc cartilages are of two types,—protrusions into the vertebral bodies, first described by Schmorl; and into the spinal canal, as first described by Stookey.

The authors in this paper report a case of intraspinal protrusion successfully operated upon and review thirty-five case reports in the literature; in forty-six per cent. the cervical vertebrae were involved, in thirty-seven per cent. the lumbar, and in seventeen per cent. the thoracic.

The cartilage projections vary in size from a pea to a bean, are usually attached to the intervertebral disc, are encapsulated and extradural. Trauma apparently plays an important rôle in their production. X-ray of the spine is negative.

The clinical picture varies with the location. The lumbar ventral chondroma gives rise to pain in the back, sciatic pain, muscle atrophy and weakness in muscles affected, loss of reflexes, and diminution or loss of sensation in segments affected. Subarachnoid block may or may not be present. Lipiodol injection is an aid in diagnosis in many cases.—*N. T. Kirk, M.D., Major, U. S. Army Medical Corps.*

POST-TRAUMATIC PAINFUL OSTEOPOROSIS. René Fontaine and Louis G. Herrmann. *Ann. Surg.*, XCVII, 26, 1933.

Bone atrophy associated with pain and vasomotor disturbances is considered true osteoporosis in contradistinction to the atrophy of disuse. The authors distinguish four clinical forms; (a) post-traumatic, (b) post-injections, (c) result of nervous disorders, and (d) dystrophic-ovarian dysfunction.

This paper is limited to consideration of the traumatic form which "is the direct result of hyperaemia produced by vasomotor changes that result from reflexes which originate in the traumatized area".

The condition is characterized by: loss of motor function and atrophy, limitation of joint motion, characteristic roentgenograms, vasomotor disturbance,—*i.e.*, oedema, cyanosis, elevation of skin temperature, and great pain. The loss of function and pain are out of all proportion to the trauma inflicted or the signs of injury found. Immobilization does not relieve pain but often increases it.

The condition is most often seen in the flat bones of the carpus and tarsus, next most frequent in the epiphysis of metacarpals, metatarsals, and phalanges, either following slight trauma or secondary to fracture. It is rare after fracture of the diaphysis of the long bones, but much more frequent in periarticular and juxta-articular regions.

From the roentgenographic study three stages in the evolution of the disease are recognized,—the onset, the height of the disease, and the reorganization.

Periarterial sympathectomy is recommended and has been carried out at Leriche's clinic in all cases since 1924 with gratifying results.

Twenty-two case reports are included and roentgenogram reproductions illustrate the article.—*N. T. Kirk, M.D., Major, U. S. Army Medical Corps.*

SULLE DEVIAZIONI DEL SACRO NEL PIANO SAGITTALE (Sacrum acutum—sacrum arcuatum). [Deviations of the Sacrum in the Sagittal Plane (Sacrum Acutum—Sacrum Arcuatum).] A. Albanese. *Arch. di Ortop.*, XLVIII, 529, 1932.

Albanese describes six cases of deviation of the sacrum in the sagittal plane, a deformity improperly designated as psuedospondylolisthesis, but which also has been designated as "sacrum acutum" and "sacrum arcuatum". The author calls attention to

the asymmetry of the pelvis that accompanies the various deviations of the sacrum and which tends to confirm the congenital nature of the disease.

In two cases there was a history of trauma that probably had increased a congenital deviation resulting in painful symptoms.

The author discusses the etiology in detail and concludes that two types, a congenital and an acquired group, exist.

The treatment is conservative with physiotherapy and orthopaedic appliances. In the severe forms a fusion operation may be indicated.—*Peter A. Rosi, M.D., Chicago, Illinois.*

Zur Lösung des Problems der Operativen Behandlung Unblutig nicht Einrenkbarer Angeborener Hüftgelenkverrenkungen (Solution of the Problem of Operative Treatment of Congenital Dislocation of the Hip not Reducible by Bloodless Method). Friedrich Loeffler. *Arch. f. Klin. Chir.*, CLXXIII, 817, 1932.

In those cases of congenital dislocation of the hip which are irreducible by bloodless methods, the pelvitrochanteric muscles are no hindrance to reduction. The pelvifemoral muscles are contracted and cannot be stretched by ordinary means without tearing or even greater damage.

The operation consists of resecting a section of the femur in its upper portion and corresponding in length to the elevation of the head above the acetabulum. The technique of the operation is described.

The functional and cosmetic results are good. There is no limp or pain and movements are free. Lordosis is corrected. The shortening of the limb can be overcome by raising the shoe.

Several cases are briefly reported.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

A Method for the Production of Increased Compression Strength of Bone: An Experimental Study (Preliminary Report). Dudley Ross. *British J. Surg.*, XX, 337, 1932.

In the first series of experiments on dogs, a section of bone was removed from the tibia, the bone rongeured into small fragments and the fragments replaced in the medullary cavity with the periosteum sutured over the defect. An Olsen testing machine was used to determine the compression strength of the repaired bone compared with the opposite tibia used as a control. It was found that four months were required for the bone to return to its former strength and that the presence of the bone fragments did not add extra strength.

In the second experiments a similar technique was used, but a detached strip of muscle was also inserted into the medullary canal. When the animals were destroyed, it was found that the muscle had disappeared, that new bone had formed in its place, that the compression strength had been increased. These experiments show that muscle tissue interposed between bone ends, provided it has lost its blood supply, becomes calcified and does not interfere with union at the usual time.

Bipartite Carpal Navicular Bone. G. I. Boyd. *British J. Surg.*, XX, 455, Jan. 1933.

It is important to remember that a congenital bipartite carpal navicular bone appears once in about a thousand persons. It is recognized by (1) absence of a history of injury, (2) the meagerness of the physical signs, and (3) the presence in the x-ray picture of a thin, well defined layer of compact bone covering the spongy bone. The other wrist is likely to show the same condition but does not always. This condition is of importance in compensation cases.

The Treatment of Tuberculous Disease of the Hip-Joint. A. S. Blundell Bankart. *British J. Surg.*, XX, 551, Apr. 1933.

This paper was read as the Presidential Address to the British Orthopaedic Association in July 1932.

A very large percentage of cases of tuberculosis of the hip joint are made latent when treated by conservative measures, only to become active later in life. While a tuberculous lesion of a joint is quite apt to be a metastatic infection from some other focus, the writer believes that it is justifiable to attack the local lesion in the joint at the same time that general hygienic treatment is being given for the lesion as a whole.

Pugh observed that tuberculosis of the hip joint begins in the inner portion of the ilium immediately above the acetabulum and spreads to the non-articular portion of the acetabulum, through the ligamentum teres to the head of the femur. The process is, then, tuberculosis of the pelvis and not of the hip joint. It is doubtful if operations tending to reduce motion in the hip joint will cure tuberculosis of the pelvis. The old type of excision of the hip did not attack the primary focus. Extra-articular fusion operations, which do not entail disarticulation of the head of the femur, prevent the ascent of the femur and closure of the tuberculous cavity formed by the destruction of the bone. Ankylosis of the hip is not a condition to be imposed on a patient if it can be avoided.

Tuberculous lesions of the spine, where the vertebrae are allowed to collapse and the abscess cavity is thus closed, give fairly good results except for the deformity. Bone graft operations prevent collapse of the vertebrae and obliteration of the cavity.

Nine cases of pelvic bone tuberculosis, quiescent for years, treated by removal of the local disease are reported. The results were so satisfactory that the author believes that early tuberculosis of the ilium should be attacked radically with the hope of eradicating the disease and preserving motion in the hip joint.

THE USE OF A MODIFIED DOUBLE THOMAS FRAME IN THE TREATMENT OF THE PARALYSES OF POLIOMYELITIS. Jean Macnamara. *British Med. J.*, II, 1098, 1932.

Dr. Macnamara describes a modification of the double Thomas frame designed to splint and relax the muscles of patients with extensive paralysis due to poliomyelitis. By means of the splint all four extremities can be kept at rest in the position of optimum relaxation of the paralyzed muscles. The abdominal muscles and trunk muscles are also splinted. The device seems of value in the care of the extensively paralyzed patient. Detailed directions for its construction are given.—*R. I. Harris, M.B., Toronto, Canada.*

THE TREATMENT OF RECENT INJURIES. W. E. Tucker. *British Med. J.*, I, 135, Jan. 1933.

Tucker contributes an article on the treatment of injuries,—chiefly contusions, sprains, and bruises received in sports. He advocates the somewhat unorthodox view that all such injuries should be treated with great vigor in order to "work out the bruise". He considers the early absorption of extravasated blood very important in order to prevent fibrosis and late disability. Treatment of a considerable variety of injuries is discussed in detail.—*R. I. Harris, M.B., Toronto, Canada.*

FRACTURES OF THE SHAFT OF THE FEMUR. W. J. Eastwood. *British Med. J.*, I, 359, Mar. 1933.

Eastwood records his experience in the treatment of sixty-one cases of simple fracture of the shaft of the femur by means of fixed traction in a Thomas splint with counter-traction against the ischial tuberosity. His recorded results are excellent. His article is in reality a plea for the use of the Thomas splint as incomparably superior to all other forms of traction and fixation; yet his own paper reveals the many features concerning the use of a Thomas splint which make it of doubtful value in most hospitals and in the hands of most surgeons.

His article leaves the impression that an enthusiastic surgeon aided by a perfect nursing staff can obtain excellent results by treating fractured femora with a Thomas splint. To credit the Thomas splint with the successful results is a mistake. They were

obtained by the unremitting and enthusiastic attention of surgeon and nurses. Similar enthusiasm and care would be rewarded by equal success, no matter what apparatus was used.

This article aroused a great deal of controversy in the correspondence columns of succeeding numbers of the *British Medical Journal*, several letters being written both for and against the use of the Thomas splint. It cannot be emphasized too strongly that fractures are never treated by apparatus. Each is an individual mechanical problem, and successful end results can only be obtained by intelligent personal supervision.

—*R. I. Harris, M.B., Toronto, Canada.*

Experimentelle Untersuchungen über die Gelenkresorption unter Verschiedenen Physikalischen Bedingungen (Experimental Investigations on Absorption from Joints under Various Physical Conditions). W. Müller und H. J. Lauber. *Bruns' Beitr. z. Klin. Chir.*, CLV, 39, 1932.

The experiments were performed on dogs and consisted of the injection into the joints of small amounts of strontium bromid and subsequent examination by roentgenography to determine the rate of absorption. It was found that application of a tourniquet delayed the process of absorption greatly, but did not entirely arrest it. Hyperaemia, when applied after the injection, also delayed the absorption, but when used previous to the injection it hastened the process.

Mechanical compression of the joint, resection of the nerves to the joint, application of heat or cold to the joint, and inflammation of the joint did not produce any noticeable change in the rate of absorption. An increased rate of absorption was brought about by active movement of the joint and by massage.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Zur Frage der Synovektomie bei Chronischen Unspezifischen Kniegelenkserkrankungen (Synovectomy in Chronic Non-Specific Diseases of the Knee Joint). A. Läwen. *Bruns' Beitr. z. Klin. Chir.*, CLVI, 153, 1932.

After reviewing briefly the literature on this subject, the author considers the various technical procedures employed in this operation and the indications for this method of treatment. He feels that synovectomy is not frequently indicated and states that among ninety-eight arthrotomies, which he performed for non-specific diseases of the knee joint, there were only two synovectomies. In each of these cases the operation was employed for the purpose of relieving a simple chronic synovitis and involved only the anterior compartment of the knee joint.

The writer also calls attention to the operation of internal arthrotomy, which consists of the production of an opening between the synovial cavity and the periarticular tissues, and permits a continuous drainage from the joint cavity.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Le Fratture della Clavicola (Fractures of the Clavicle). Giuseppe Rotolo. *Clin. Chir.*, VIII, 874, 1932.

Giuseppe Rotolo reports on a series of fractures of the clavicle treated in various clinics under the direction of Prof. Rossi at Milan. The report is based upon 342 fractures of the clavicle studied and treated from 1905 to 1931, but it is limited to twenty-seven fractures, chosen from among those it was possible to examine at a late date and including the various types.

Nineteen of the cases that were given in detail were treated by Bardenheuer's method of traction with weights, modified by Rossi. He gives a very clear description of the method which consists of keeping the patient recumbent for about fifteen days with the arm in abduction and supination. A Balkan frame is used with the arm supported in a hammock. Rotolo states that function rather than absolute anatomical reposition should be the measure of the result, but with the Bardenheuer-Rossi method anatomical reposition is also satisfactory.

In Rossi's clinics the experience with cases subjected to open reduction has not been good, and he quotes various authors who also have had unsuccessful results. Nevertheless he quotes a number of surgeons who recommend open operation as the treatment of choice.

The paper is well illustrated and the authorities well correlated. The illustrations alone give an excellent idea of the anatomy and physiology involved and also of the method advised.—*Murray S. Danforth, M.D., Providence, R. I.*

Über Halswirbelbrüche (Fractures of the Cervical Spine). M. Laesecke. *Deutsche Ztschr. f. Chir.*, CCXXXVI, 329, 1932.

Ten cases are reported. The author advocates the utmost conservatism in treatment. Even in severe cases, with more or less marked injury to the spinal cord, conservative measures will produce a decided improvement, and not infrequently lead to conditions which are practically normal.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Sarkom bei Ostitis Deformans und Osteodystrophia Fibrosa (Sarcoma with Osteitis Deformans and Osteitis Fibrosa). R. Wanke. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 198, 1932.

From a critical review of the literature and from personal observations the author concludes that osteitis deformans has a tendency to sarcomatous degeneration. The presarcomatous nature of osteitis deformans is especially evident in cases having a multilocular origin of sarcoma. Altogether, fifteen cases are reported in which osteitis deformans and sarcoma were associated. A statistical determination of the incidence of sarcoma on the basis of osteitis deformans cannot be made, because it is not possible to consider all cases of osteitis deformans as being free from sarcoma. Sarcoma occurs, indeed, in only a small percentage of cases; yet, when it is found, it is to be considered as a circumscribed or a diffuse sarcomatous degeneration of osteitis deformans. In this sense we can and may speak of a presarcomatous affection of osteitis deformans. However, with regard to the origin of sarcoma, other factors must play a rôle. Trauma can be considered only as a coincidence, as is proven especially in cases with multiple sarcoma.

Osteitis fibrosa, on the other hand, shows no tendency to sarcoma formation. From original observations and a review of the literature, the association of sarcoma with osteitis fibrosa can be conclusively proved only in exceptional instances. One case which the author previously reported as a sarcoma, on the basis of osteitis deformans, was on subsequent observation found to be a sarcoma associated with osteitis fibrosa. The remaining forty-one cases of localized osteitis fibrosa gave indications of the existence of the disease for periods of ten to twenty-seven years, and in cases of brown tumors (twenty-seven cases), all were under observation for more than five years, yet no other case was found to have sarcoma. The conception that osteitis fibrosa, like osteitis deformans, represents a presarcomatous condition cannot be upheld.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Über Traumatische und Pathologische Querfortsatzbrüche der Lendenwirbelsäule (Traumatic and Pathological Fractures of the Transverse Processes of the Lumbar Spine). Max Ernst und Römmelt. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 580, 1932.

The authors call attention to the controversies regarding incidence, recognition, methods of production, and treatment of this injury. This is followed by an analysis of fifty of their own cases.

A certain diagnosis can be made only by means of x-ray examination. This is made more difficult due to the large number of anatomical variations in the transverse process. Several different forms of anomalies are illustrated by diagram with descriptions of their characteristics.

Bony union occurs in only two-thirds of the cases of fracture; three to four months

are required for complete healing. Bony union did not occur in any case in which the fracture line was still noticeable four months after the injury. Small isolated fragments of bone may be detected in the soft tissues for years after separation from the rest of the vertebra. A failure of bony union is insignificant for future function.

Late symptoms are exceptional and may be produced by pressure of the fragment on the lumbar nerves.

The article includes a number of case reports with x-ray illustrations.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

BEITRAG ZUR SCHÄDIGUNG DER KNORPELBINNENSCHEIBEN DER KNIEGELENKE (Contribution to the Study of Injuries of Cartilages of the Knee Joint). Remmer Andreesen. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 602, 1932.

From the study of 150 cases of injuries to the cartilages of the knee joint, the author gives an accurate and detailed description of the macroscopic and microscopic changes noted in the affected tissues. Regenerative changes are described as they occur in the separated meniscus and the capsular remains.

The ages of twenty-eight to thirty years are most favorable for such injuries.

Separation of the lateral portions of the meniscus is in most instances considered a pathological fracture, and brought about by previous changes in the meniscus several millimeters from the attachment. Clinically, a pathological fracture presents the same picture as a traumatic separation.

The numerous cases of serous effusion into the knee joint are explained by vascular changes. In a genuine traumatic separation bloody fluid is present as a rule.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

PERIARTHRITIS OF THE SHOULDER. An Analysis of Two Hundred Cases. James A. Dickson and Edward H. Crosby. *J. Am. Med. Assn.*, XCIX, 2252, 1932.

In an effort to elucidate the relationship of trauma, focal infection, and metabolic factors in the etiology of periarthritis of the shoulder and to determine the most efficacious treatment for that condition, the authors have analyzed a series of 200 cases. They prefer the term "periarthritis of the shoulder" rather than subacromial bursitis, subdeltoid bursitis, etc., since calcifications, torn tendons, etc., do not explain the whole pathological picture. Periarthritis is a distinct entity and presents a definite distinct clinical syndrome. There is always a limitation of abduction to about forty-five degrees and internal and external rotation is limited about fifty degrees, while forward and backward motions are perfectly free and painless.

The author's study shows that the presence of calcium demonstrated by the roentgenogram is no indication of the severity of the condition. Some roentgenograms of shoulders showed a calcified area present and the patient had no pain whatever. Others showed no calcification at all, yet the patients had very severe pain. The analysis shows that foci of infection and glandular dysfunction appear to be more important than trauma as etiological factors, although it is extremely difficult to evaluate their true significance. Calcium deposits are found in about the same percentage of cases, regardless of whether the etiological agent was attributable to metabolic, glandular, or infectious agents.

The treatment is divided into two phases, local and general. The general treatment consists of elimination of foci of infection, attention to the metabolic condition of the patient,—as, for example, whether they are hypothyroid or hyperthyroid types, whether they are potential diabetics, etc. Unless contra-indicated a low carbohydrate, high vitamin diet is usually prescribed.—*W. B. Carrell, M.D., Dallas, Texas.*

BILATERAL DISEASE OF THE INTERNAL CUNEIFORM BONE WITH AN ASSOCIATED DISEASE OF THE RIGHT SCAPHOID BONE (KÖHLER'S). Edward J. Haboush. *J. Am. Med. Assn.*, C, 41, 1933.

The author observes that there has been within recent years a greatly stimulated

interest in that peculiar set of disease conditions, such as Legg-Perthés' disease, Kienböck's disease, etc., and notes that most of the observations on the pathology of these several conditions seems to be an aseptic necrosis characterized by a fibrous infiltration of the bone extending in from the periosteum. He reports a case in which this disease process has involved the right scaphoid and both internal cuneiforms. This patient, a child of four and one-half, complained of pain in the left foot. Both feet were in severe pronation and there was a noticeable swelling along the inner border of the dorsum of the left foot. There was slight tenderness to pressure over the right internal cuneiform and scaphoid bones. Palpation of the left foot revealed local heat in the region of the swelling and pressure over the internal cuneiform was very painful. Right foot motions were free, while the left foot was held in eversion because of marked peroneal spasm. Inversion was painful. An x-ray showed that in the right foot the internal cuneiform and the scaphoid were affected, while in the left foot the internal cuneiform only was involved in this peculiar pathological process. A thorough search of the literature by the author failed to reveal a report of any such similar condition hence it was deemed worthy of report.—*W. B. Carrell, M.D., Dallas, Texas.*

Ruptures and Tears of Muscles and Tendons of the Lower Extremity. Report of Fifteen Cases. Edgar L. Gilcreest. *J. Am. Med. Assn.*, C, 153, 1933.

The author points out the paucity of literature on this subject and states that many cases of supposed sprain of a joint, arthritis, neuritis, etc., are in reality partial ruptures of certain tendons and muscle bellies. If these are diagnosed early and attended to properly by effective surgical interference, much quicker return to activity is accomplished and the end result is much better in practically all of the cases.

The tears occur most often in tendons or muscles which are fatigued or senile or have within them some pathological change, and it is usually an unexpected movement, bringing about a sudden powerful contraction of the muscle, that causes the tear to occur. Investigations have shown that the calf muscles come first in frequency, then the extensors of the leg, the biceps of the arm, the Achilles tendon and, last, the extensor of the thumb. Many cases of back pain or lumbago are in reality torn or partially ruptured fascial layers or muscles of the back.

The knee flexors that are most often ruptured are the semitendinous and the inner head of the gastrocnemius. The calf muscles, plantaris muscle, and the tendo achillis are also frequently injured, and the author discusses the findings to be expected in each case, with the additional presentation of several cases showing how this has happened in his patients and the results after operative repair.—*W. B. Carrell, M.D., Dallas, Texas.*

The Pathology of Monomelic Flowing Hyperostosis or Melorheostosis. Ernest Kraft. *Radiology*, XX, 47, Jan. 1933.

This condition is a progressive hyperostosis, usually involving one side of the shaft of one or more of the bones of an extremity, non-malignant, and of unknown etiology. Nineteen cases are reported in the literature.

The hyperostosis may form a continuous flow, or appear as interrupted plaques; its appearance Leri compared to the molten stream of a candle. The disease is usually confined to a single extremity. The hyperostosis seems to follow the course of the vessels and nerves.

The gross appearance is that of sclerotic bone, and microscopic study bears out this resemblance. The joints are usually not involved.

The onset is slow, with vague rheumatic pains and bowing of the extremities in advanced cases. There may be mechanical interference with joint action. The disease begins in early life, but does not affect the general health.

Laboratory findings are negative and there is no known treatment. The disease may remain stationary for years.—*Edward N. Reed, Santa Monica, California.*

POSITIVE PRESSURE IN ARTHRODESIS OF THE KNEE JOINT. J. Albert Key. *Southern Med. J.*, XXV, 909, 1932.

On account of many failures to get firm bony ankylosis in arthodesing tuberculous knees, Key has devised this method: inverted U incision; complete excision of synovial membrane, semilunar cartilages, ligaments, etc.; cut off the condyles of femur, and of the tibia, and articular surface of patella with a saw. A heavy stainless steel pin is then drilled through the lower end of femur and another through the upper end of tibia so they are parallel. A small turnbuckle is fitted on each side and tightened enough to hold the bone ends firmly together. A snug plaster-of-Paris cast is applied from toes to groin. Tourniquet is then removed. A narrow window is cut out on each side to expose the turnbuckles which are then tightened so as to slightly bend the pins. Patient is put to bed with leg elevated. The turnbuckles are kept tight and the pins left in place eight weeks. If union is firm the pins are removed. Another snug cast is applied from toes to groin. Patient is allowed up on crutches, but no weight-bearing is permitted until sixteen weeks after operation. If there is any doubt about firm union a cast is again applied. Five cases in adults were so treated; four obtained solid union in an unusually short time; one died of sepsis. Two cases are reported in detail.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

PROGRESSIVE PSEUDOHYPERTROPHIC MUSCULAR DYSTROPHY. Allen F. Voshell. *Southern Med. J.*, XXVI, 156, 1933.

The history, types, heredity, pathology, clinical features, chemistry, diagnosis, and prognosis are discussed. The recent methods of treatment by the injections of adrenalin and pilocarpin are considered. The author then presents statistical data of fourteen cases treated for six months or longer with glycin. Nine cases showed improvement of more or less degree. Five did not improve, one becoming worse. The younger the case, and the earlier the treatment is started, the better the prognosis. Active physiotherapy is given during the treatment. He suggests the combination of the adrenalin and pilocarpin treatment with injections of glycin. He advises against putting the patients to bed unless it is absolutely necessary.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

OLD TRAUMATIC DISLOCATION OF THE HIP: WITH SPECIAL REFERENCE TO THE OPERATIVE TREATMENT. Leo J. Miltner, and F. E. Wan. *Surg. Gynec. Obstet.*, LVI, 84, 1933.

This rather uncommon condition has been encountered in sixteen cases reviewed by the writers. A discussion of the pathological anatomy is divided into posterior and anterior positions of the femoral head in relation to the acetabulum. In the former the capsule is torn postero-inferiorly and one or more of the small rotator muscles is torn, though occasionally the head passes between them. The Y ligament is intact and causes the typical position of flexion, adduction, and internal rotation. Contractures soon form and in three or four weeks the acetabulum is filled with adherent soft tissue. Changes in the femoral head are constantly present, often with considerable new bone formation.

Closed reduction may be attempted up to four weeks after injury with expectation of accomplishment, but after this time the open operation is preferable. The latter should be preceded by a period of skeletal traction. The operative technique is described, an approach by the Smith-Petersen incision being recommended. Complete reduction was accomplished in each case though the possibility of a shelf, resection, fusion, osteotomy, or bifurcation was discussed. Results are recorded as excellent in nine, good in one, fair in four, and poor in two cases. The serious complications encountered were infection (two cases), sciatic nerve injury (one case), and fracture of the femoral head during manipulation (one case).

Eighty per cent. showed markings of hypertrophic arthritis in follow-up roentgenograms, usually of mild nature clinically.—*Richard McGovney, M.D., Los Angeles, California.*